All About OCEANOGRAPHY

A Fun-Filled Activity Book

About the Cover . . .

Not very long ago, scientists diving underwater in the submersible, Alvin, discovered places on the ocean floor where very, very hot water, minerals, and poisonous gases were shooting out, called **hydrothermal vents**. The water, fluids, and dissolved gases come out of thin "chimneys," called **black smokers**. Amazingly, the temperature of the materials coming out of the black smokers is so hot it nearly melted the portholes of Alvin, but the temperature of the seawater just outside the chimneys is almost freezing! Robots like the one pictured on the cover (called *Jason*) also explore hydrothermal vent areas. *See page 18 for more facts and information about hydrothermal vent communities.*

NOTE: Throughout *All About Oceanography* you will notice that some words in the text will appear in **bold** type. The definitions for these words are printed in the glossary, on pages 30 & 31.

A very special thanks to Sheri DeRosa, who created the fun (and challenging!) word puzzles and glossary.

References:

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Coulombe, Deborah A. 1984. *The Seaside Naturalist. A Guide to Study at the Seashore.* (Prentice Hall Press, New York, NY), 246 p.

Groves, Don. 1989. *The Oceans: A Book of Questions and Answers.* (John Wiley and Sons, Wiley Nature Editions, New York, NY), 203 p.

Leatherwood, Stephen and Randall R. Reeves. 1983. *The Sierra Club Handbook of Whales and Dolphins,* (Sierra Club Books, San Francisco, CA), 302 p.

Massachusetts Water Resources Authority. 1992. "Home Water Conservation Guide," MWRA Water Works Division, 19 p.

Soil and Water Conservation Society ("Water in Your Hands," Teacher's Guide), SWCS, 7515 N.E. Ankeny Road, Ankeny, IA 50021-9764, 4 p.

"88 Action Tips for Cleaner Water," produced by WCBS News 88 (NY) and the Tri-State Area Sea Grant Programs (CT, NY, NJ), 1990, NJ Sea Grant Program, Building 22, Fort Hancock, NJ 07732, 22 p.

"The Watershed at Bay: A Watershed Awareness Curriculum," developed by the Waquoit Bay National Estuarine Research Reserve and the University of Massachusetts Cooperative Extension Service, 1991, WBNERR, Box 3092, Waquoit, MA 02536.

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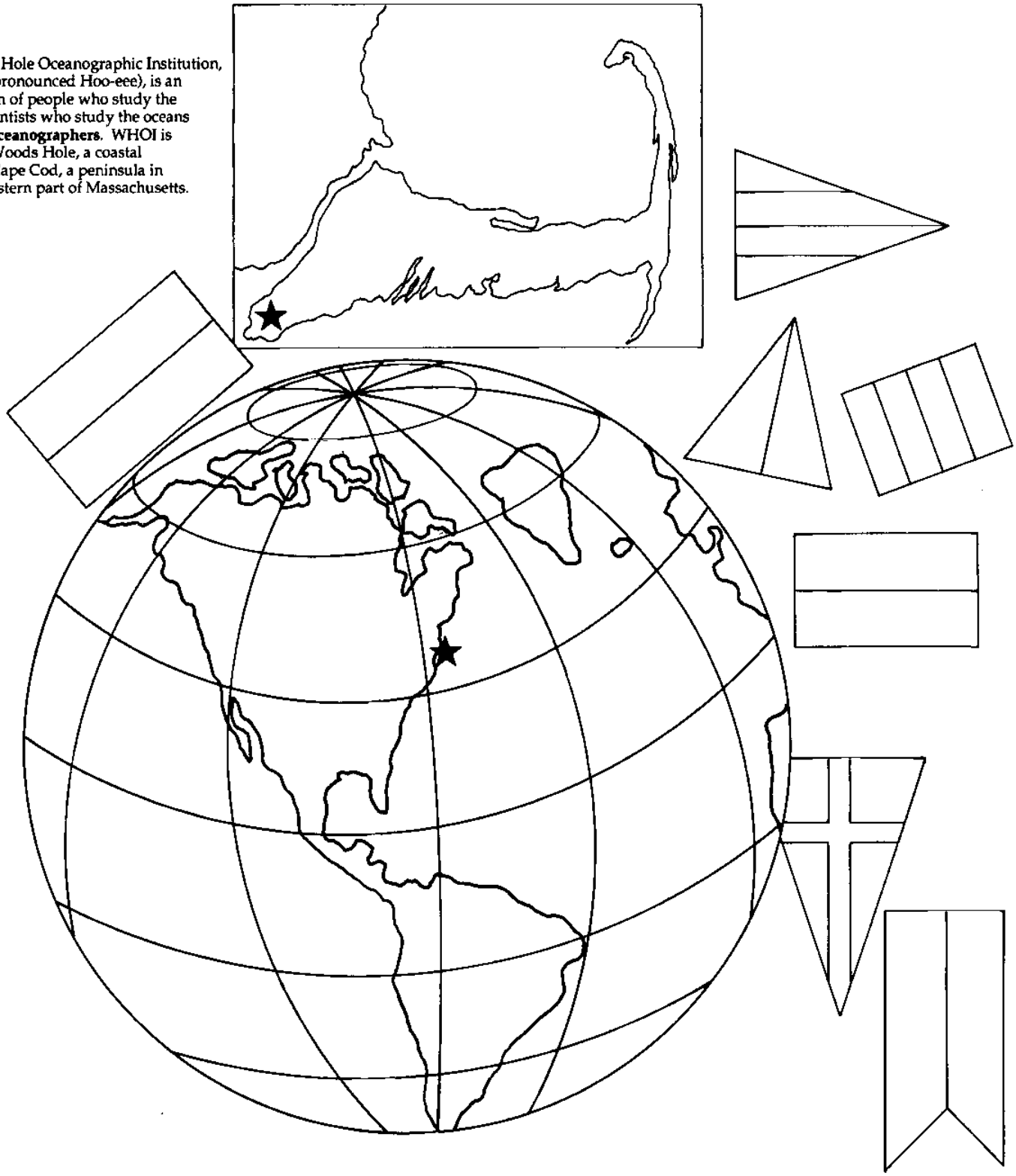
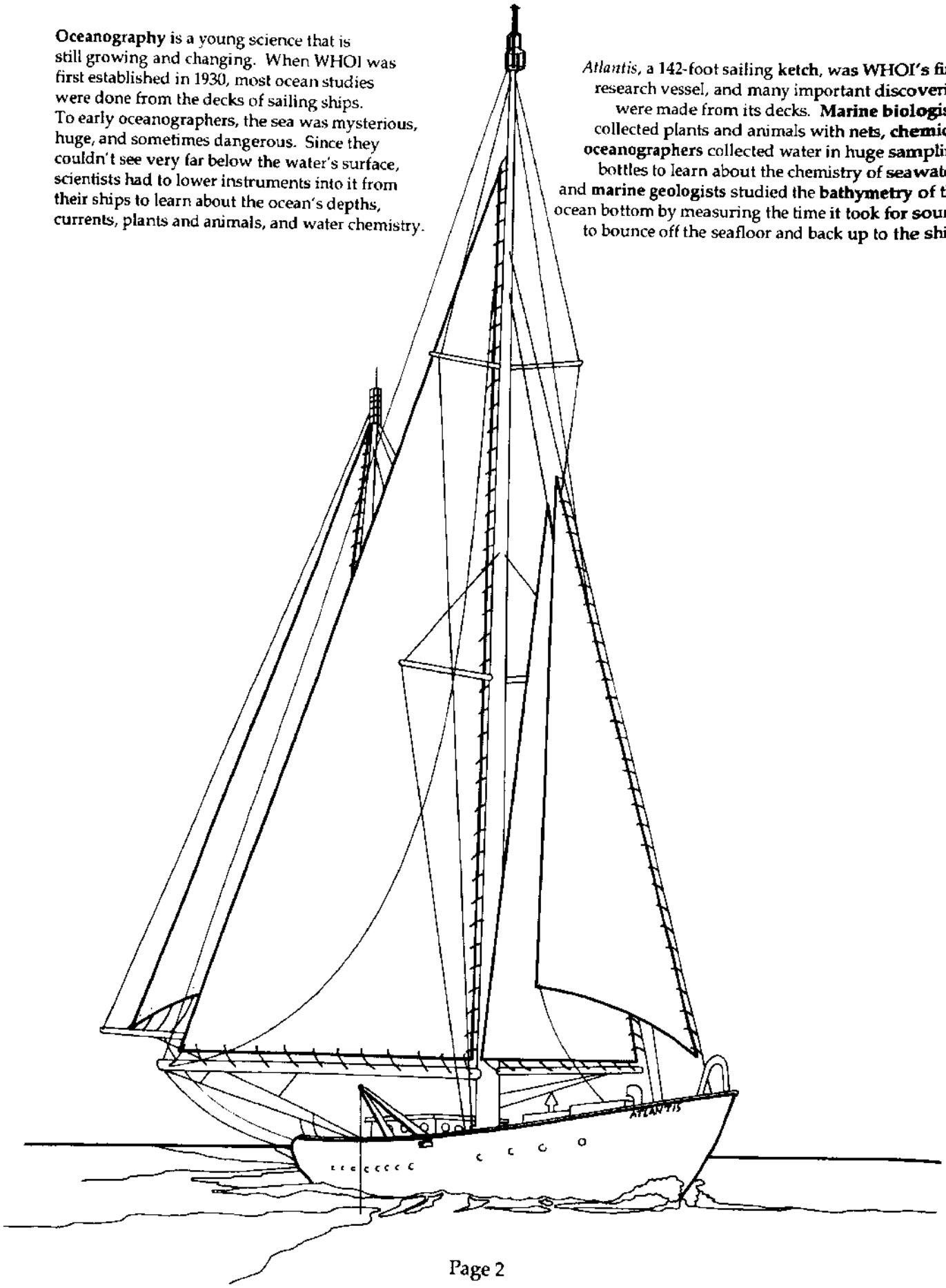
The Woods Hole Oceanographic Institution, or WHOI (pronounced Hoo-eee), is an organization of people who study the oceans. Scientists who study the oceans are called **oceanographers**. WHOI is located in Woods Hole, a coastal village on Cape Cod, a peninsula in the southeastern part of Massachusetts.

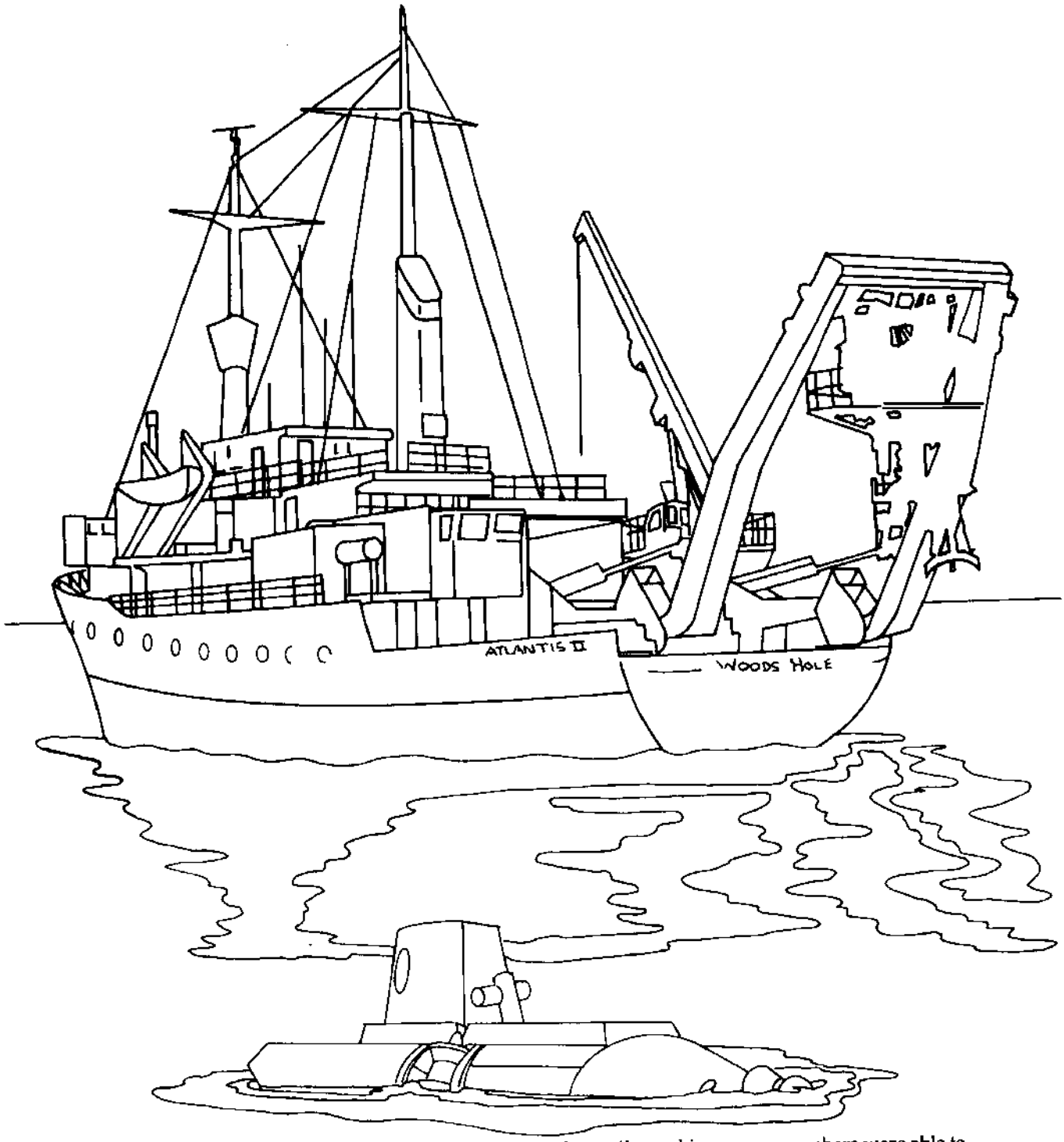


The scientific research that oceanographers conduct is valuable because the oceans are important in the lives of all people. Since the Earth's four oceans and twenty seas together cover almost three-quarters of the globe, oceanographers think of them collectively as the global ocean. Even though we live on the *blue planet* (this is how astronauts describe the Earth as seen from space), oceanographers have learned very little of what they want to know about the oceans. For example, how does the ocean affect the air we breathe and the **climate** in which we live? In what other ways are humans dependent upon the sea, and how can we best protect this important environment? These are the types of questions that oceanographers at WHOI are seeking answers to.

Oceanography is a young science that is still growing and changing. When WHOI was first established in 1930, most ocean studies were done from the decks of sailing ships. To early oceanographers, the sea was mysterious, huge, and sometimes dangerous. Since they couldn't see very far below the water's surface, scientists had to lower instruments into it from their ships to learn about the ocean's depths, currents, plants and animals, and water chemistry.

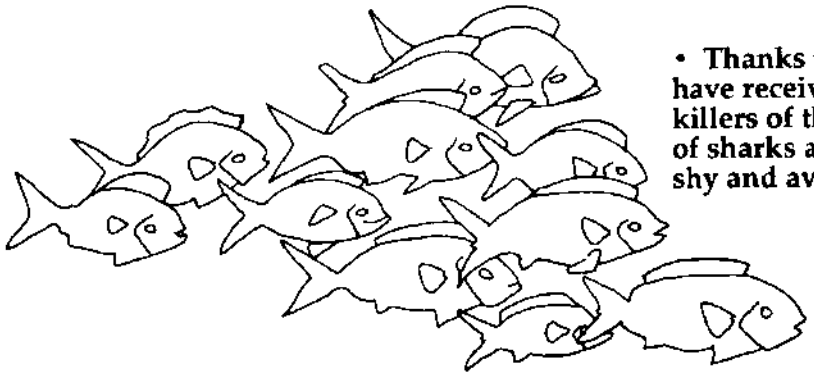
Atlantis, a 142-foot sailing **ketch**, was **WHOI's** first research vessel, and many important **discoveries** were made from its decks. **Marine biologists** collected plants and animals with **nets, chemical oceanographers** collected water in huge **sampling** bottles to learn about the chemistry of **seawater**, and **marine geologists** studied the **bathymetry** of the ocean bottom by measuring the time it took for sound to bounce off the seafloor and back up to the ship.





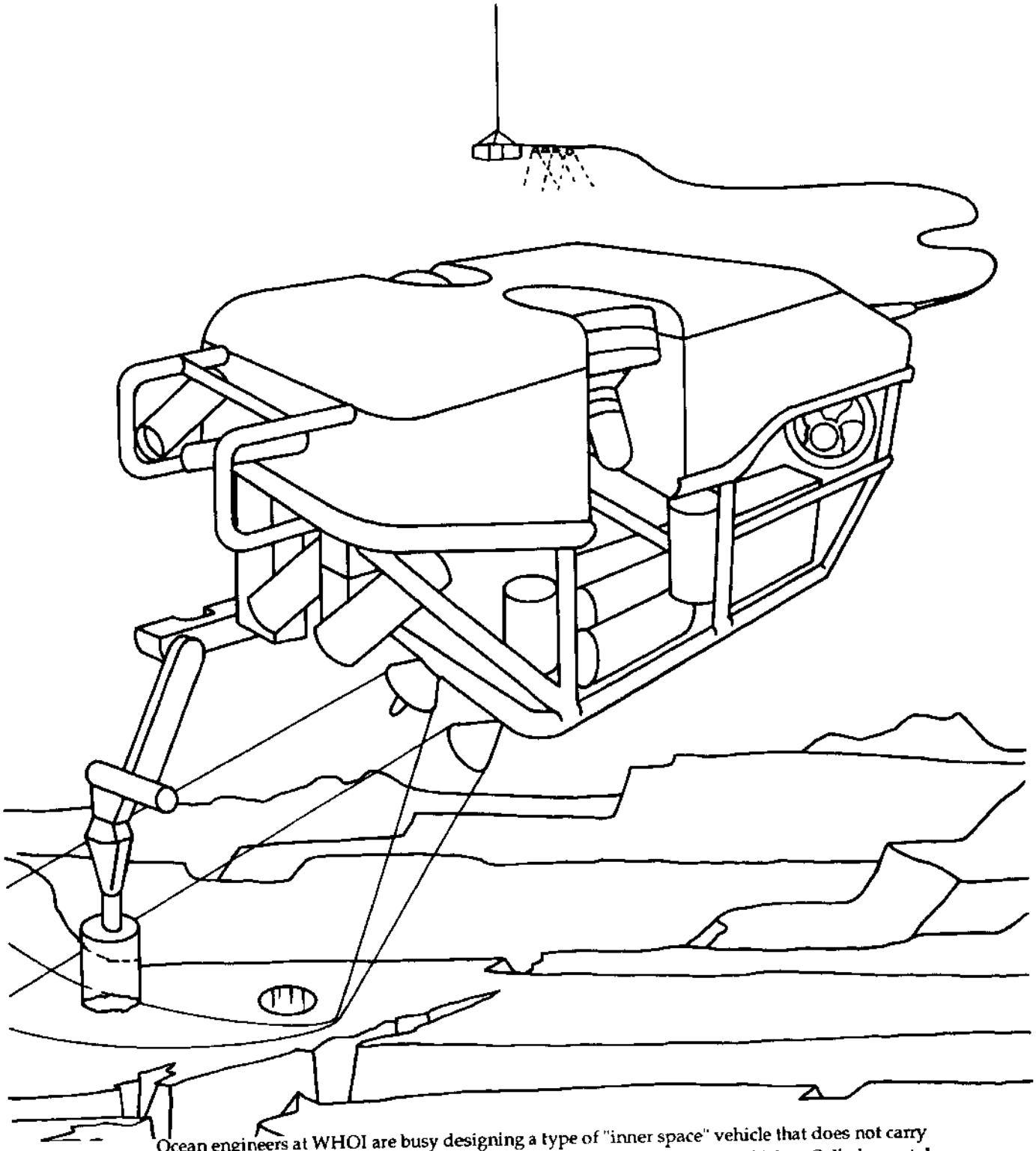
As the years went by, and engines began to replace sails on ships, oceanographers were able to explore more of the ocean in a shorter time. The *Atlantis* was sold in 1964, and a new research vessel, the *Atlantis II*, was added to WHOI's fleet. The ship's diesel engines enabled it to remain at sea for long periods of time and take samples of water, animal and plant life, and **sediment** from oceans throughout the world.

Even today, oceanography presents researchers with many challenges and frustrations: giant waves and rough weather make shipboard research difficult, and collecting samples from a ship does not always give scientists a very clear picture of the environment beneath the waves. Although no one has figured out a way to control the weather, ocean engineers have helped solve the problem of not being able to see the world beneath the sea by designing underwater vehicles, or **submersibles**. WHOI's three-passenger submersible *Alvin* is one example. The *Atlantis II* carries *Alvin* all around the world, and the ship's crew launches and retrieves the sub and its passengers during hundreds of dives each year.



• **Thanks to movies and television, sharks have received a reputation as dangerous killers of the oceans. In fact, most types of sharks are not only harmless, they are shy and avoid humans when possible.**

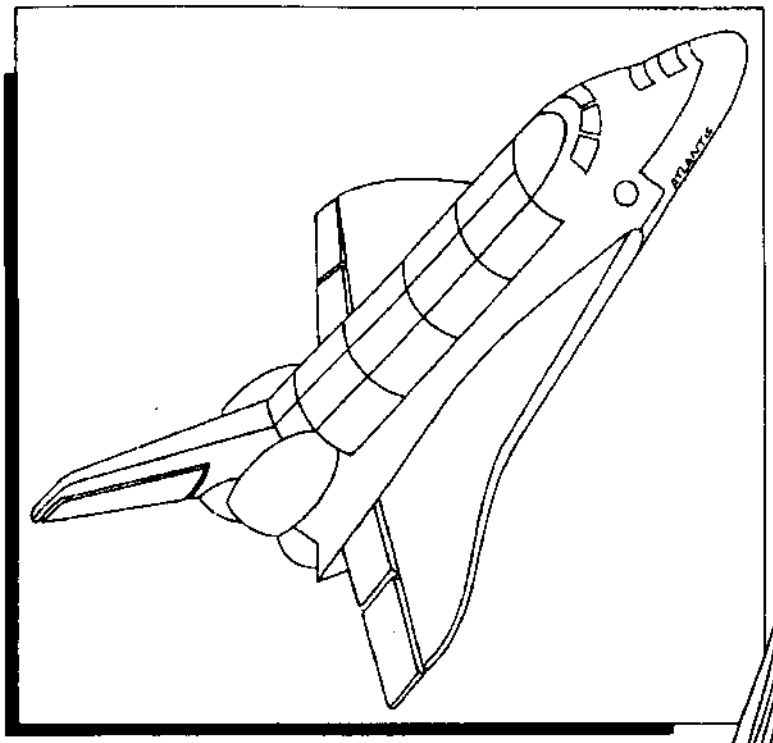
The use of **SCUBA**, or Self Contained Underwater Breathing Apparatus, is another way for scientists to view the underwater world. But even with SCUBA gear, people can go only slightly deeper than 100 feet. Since the average depth of the oceans is about two miles, SCUBA divers can explore only the thin layer near the surface. Just as astronauts need special ships to carry them into outer space, oceanographers must rely on vehicles like *Alvin* to take them to "inner space." *Alvin* is specially designed to protect its passengers from the immense pressure and the freezing temperatures in the deep sea, and the submersible's lights allow people to see into an environment that is too deep to receive any light from the sun. *Alvin's* **manipulator arm** enables the pilot to pick up rock, plant, and animal samples and place them in a collecting basket for the ride to the surface.



Ocean engineers at WHOI are busy designing a type of "inner space" vehicle that does not carry people. They can go deeper into the ocean and stay down longer than manned vehicles. Called **remotely operated vehicles**, or ROVs, these robots are remotely controlled by a researcher seated comfortably aboard a ship. Lights and cameras mounted on the ROV illuminate the underwater world and send pictures to the surface through special cables that connect the ROV to the ship above.

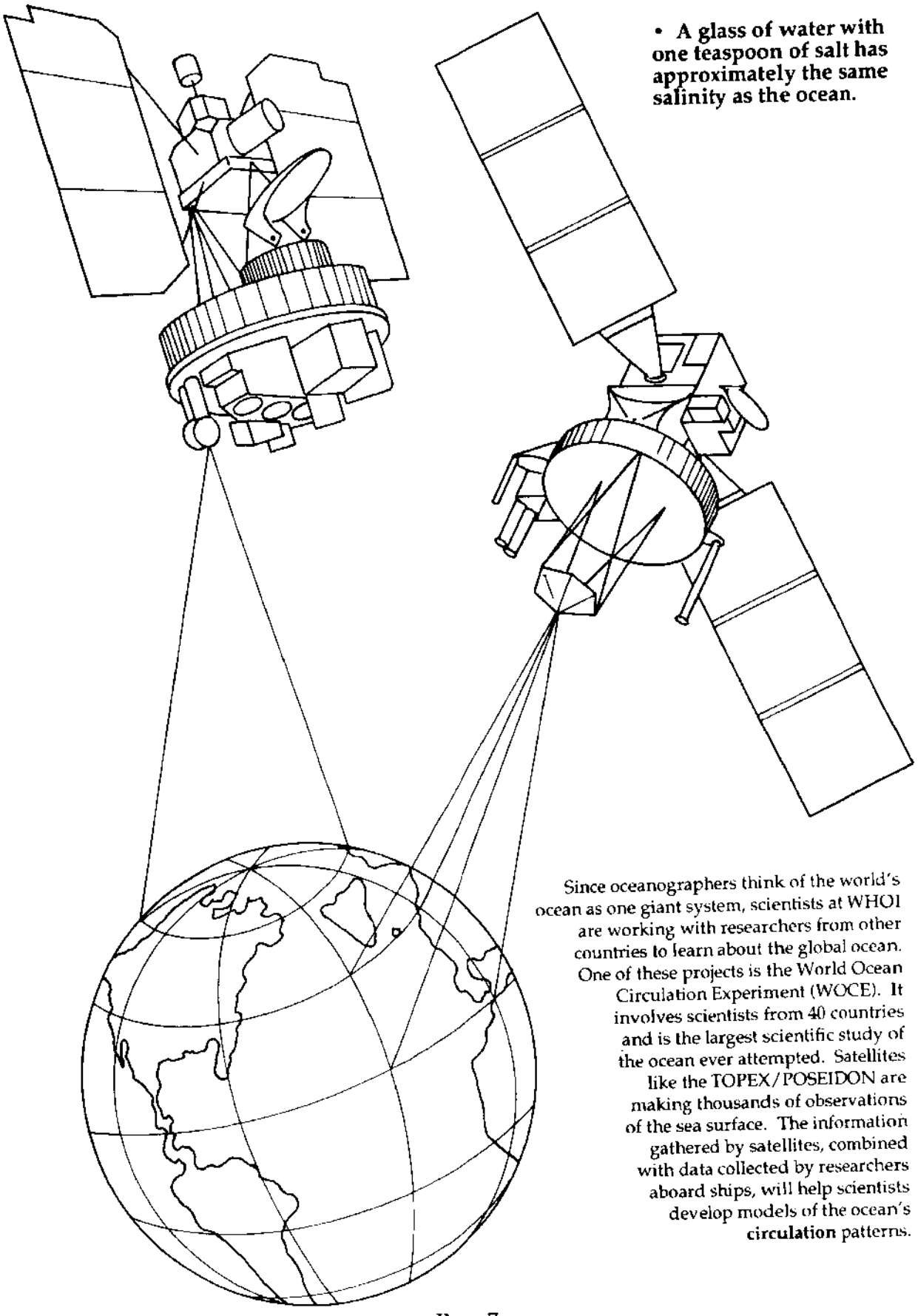
Special computerized controls allow the ROV pilots to collect **cores** with a manipulator arm. The picture of WHOI's ROV *Jason* (above), shows how a pilot can instruct the robot's arm to push a hollow cylinder down into the bottom and pull it back out to collect a core. Once back on the ship, the cylinder can be sliced open to reveal various layers of mud. Marine geologists study these core samples to learn more about the history of the Earth and the plants and animals that lived in the ocean thousands of years ago.

• **The ocean often looks blue because the sun shines on tiny particles suspended in the water.**



• **Did you know that each of the United States' space shuttles has been named after a well-known oceanographic ship? The space shuttle *Atlantis* was named for WHOI's original sailing research vessel. The shuttles *Endeavour* and *Challenger* are also named after ships that have explored our blue planet.**

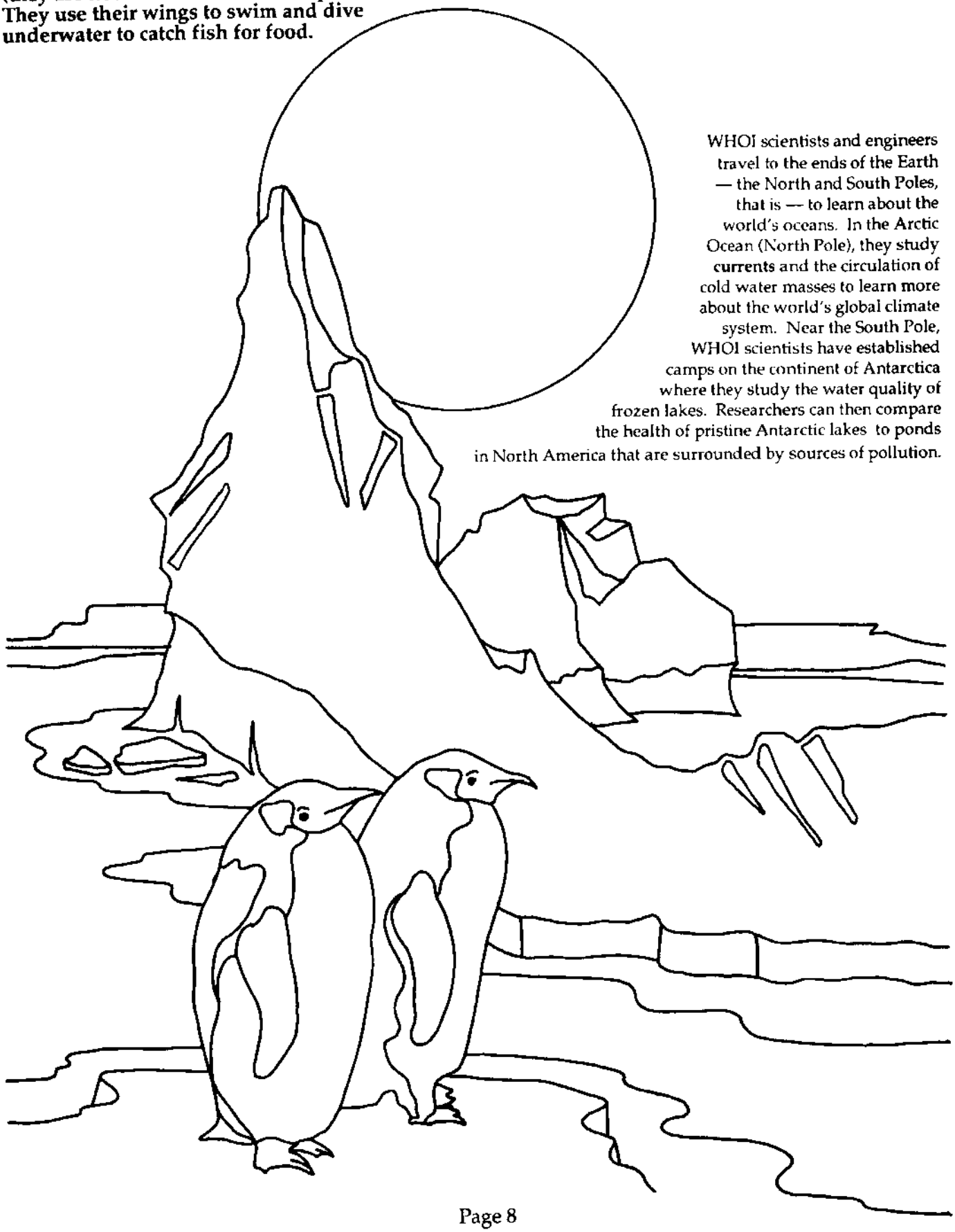
Even though astronauts explore outer space and oceanographers explore "inner space," they have many things in common. Pictures of the world's oceans taken from space have given oceanographers important information about currents, temperatures, and other properties of the global ocean. Satellites that orbit the Earth send data to the laboratories of oceanographers around the world. Ocean information collected in space helps oceanographers learn about global climate change and other environmental problems.



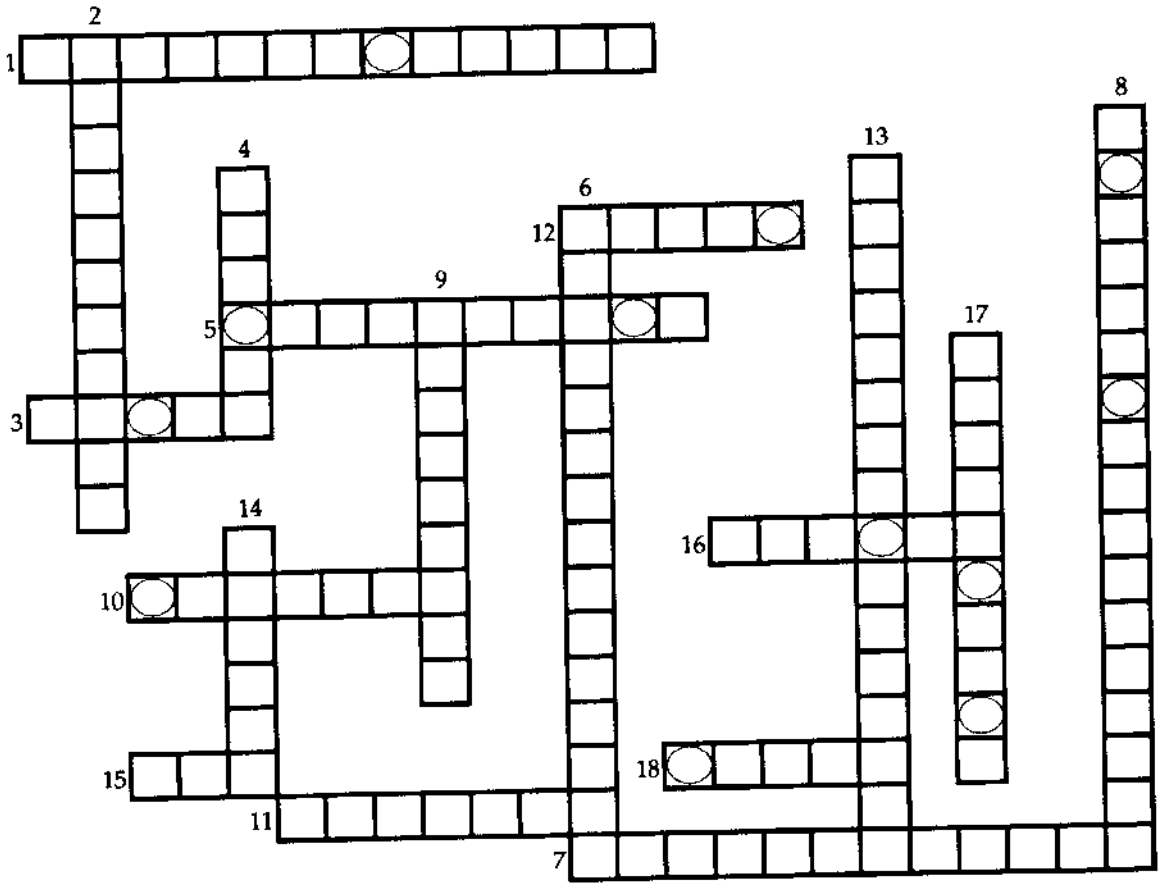
• **A glass of water with one teaspoon of salt has approximately the same salinity as the ocean.**

Since oceanographers think of the world's ocean as one giant system, scientists at WHOI are working with researchers from other countries to learn about the global ocean. One of these projects is the World Ocean Circulation Experiment (WOCE). It involves scientists from 40 countries and is the largest scientific study of the ocean ever attempted. Satellites like the TOPEX/POSEIDON are making thousands of observations of the sea surface. The information gathered by satellites, combined with data collected by researchers aboard ships, will help scientists develop models of the ocean's **circulation** patterns.

• **Penguins are flightless birds that live in the Southern Hemisphere (they are not found north of the equator). They use their wings to swim and dive underwater to catch fish for food.**

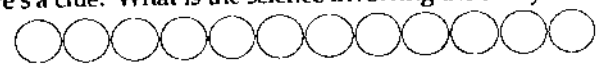


WHOI scientists and engineers travel to the ends of the Earth — the North and South Poles, that is — to learn about the world's oceans. In the Arctic Ocean (North Pole), they study currents and the circulation of cold water masses to learn more about the world's global climate system. Near the South Pole, WHOI scientists have established camps on the continent of Antarctica where they study the water quality of frozen lakes. Researchers can then compare the health of pristine Antarctic lakes to ponds in North America that are surrounded by sources of pollution.



What is the hidden word? Unscramble the letters in boxes with circles to find out!

(Here's a clue: What is the science involving the study of the ocean?)



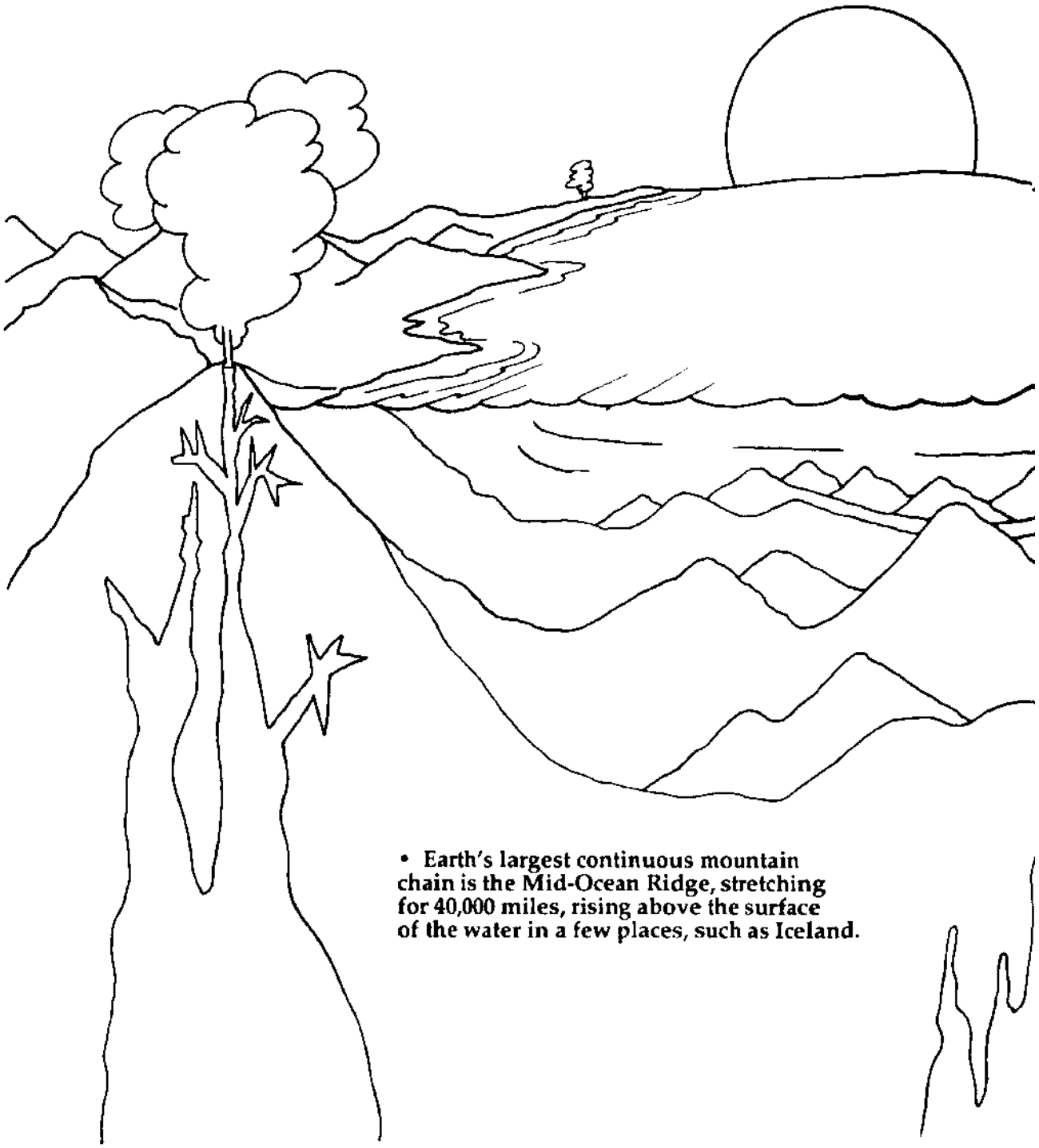
ACROSS

1 Warm blooded vertebrates that live in the sea
3 Moored or anchored objects
5 North Atlantic Ocean current
7 Small underwater research vessels that carry people
10 Process by which the Earth is worn away by winds, waves, tides, or currents
11 Harmful bloom of algae
12 97% of the Earth's water supply is in the ____
15 One of the three states of matter
16 Flat-topped undersea submarine mountains
18 Samples of sediments taken from the ocean floor

DOWN

2 Farming of the ocean
4 Undersea mountain ranges
6 Depressions of the ocean floor
8 Pockets of mineral-rich water escaping from the sea floor
9 Material in the oceans that settles on the ocean floor
13 Oceanographers who study the ocean's floor and coasts
14 Representations of real things
17 Envelope of gases surrounding the Earth

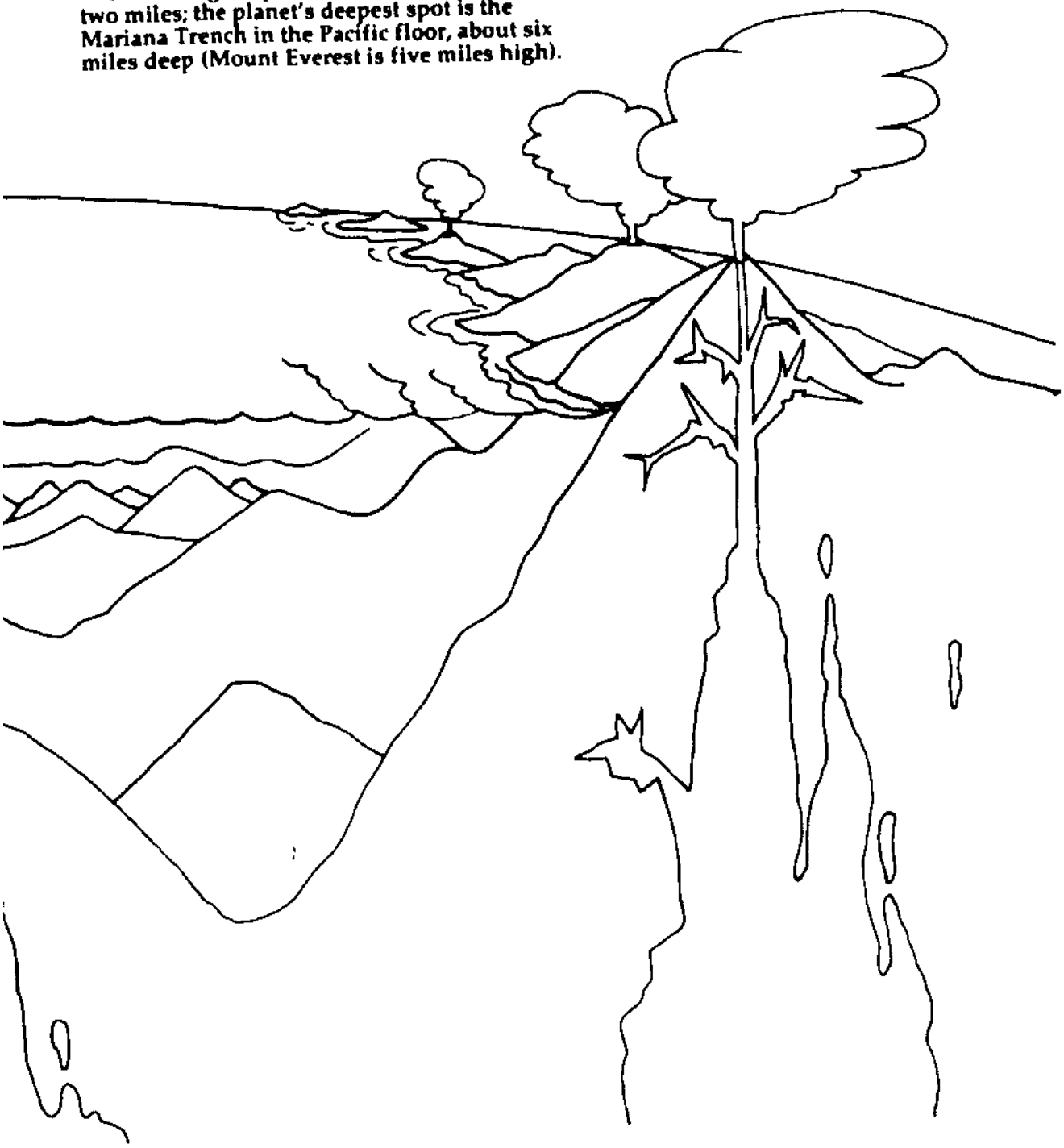
For Answers, See Page 32



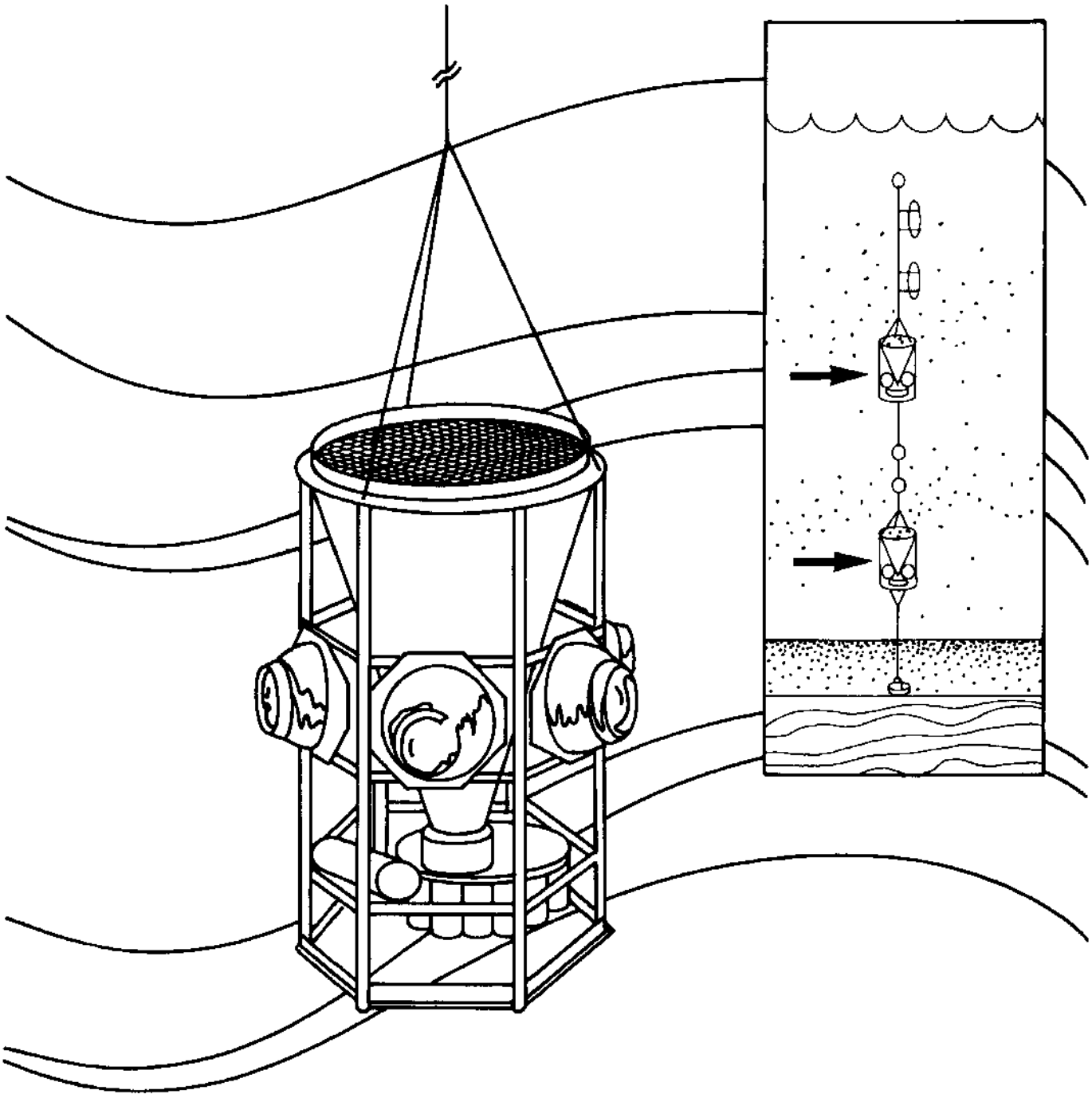
• **Earth's largest continuous mountain chain is the Mid-Ocean Ridge, stretching for 40,000 miles, rising above the surface of the water in a few places, such as Iceland.**

Did you know that the floor of the ocean is very similar to the surface of land? There are mountain ranges at the bottom of the ocean known as **ridges**, deep valleys, known as **oceanic trenches**, flat-topped underwater mountains, known as **guyots**, volcanoes, and islands. Oceanographers who study the ocean's floor and coasts are called marine geologists.

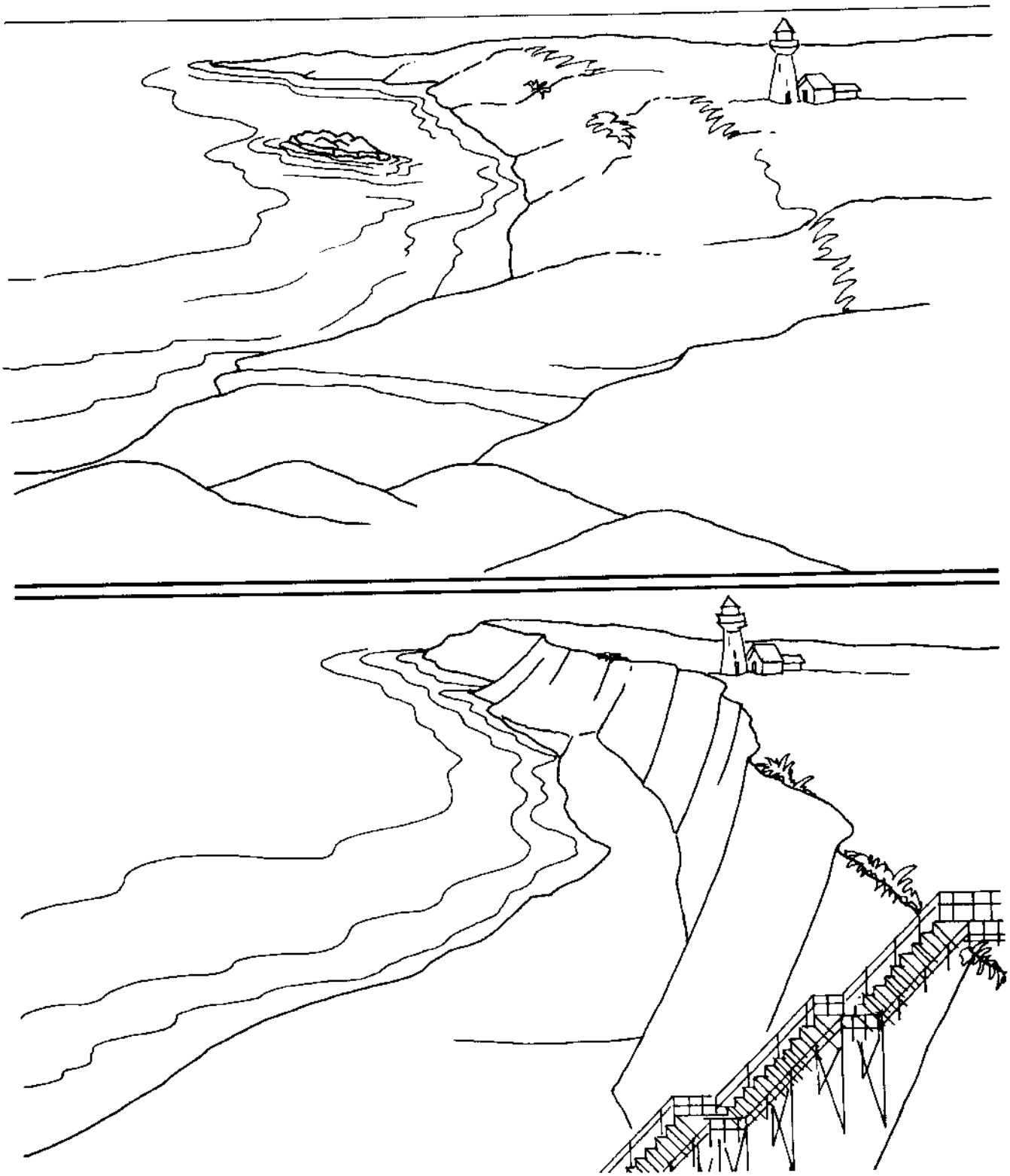
• **The average depth of the ocean is about two miles; the planet's deepest spot is the Mariana Trench in the Pacific floor, about six miles deep (Mount Everest is five miles high).**



Minerals found in the ocean are known as marine minerals. Mineral deposits are areas where certain types of minerals can be found; for example, mineral deposits can be found underground, in mountains, swamps, or under the ocean. Scientists and people in the field of **marine policy** are studying ways of finding and using marine minerals to provide us with **energy** and **resources** for everyday activities, like heating or air conditioning our homes or driving our cars, boats, and motorcycles.

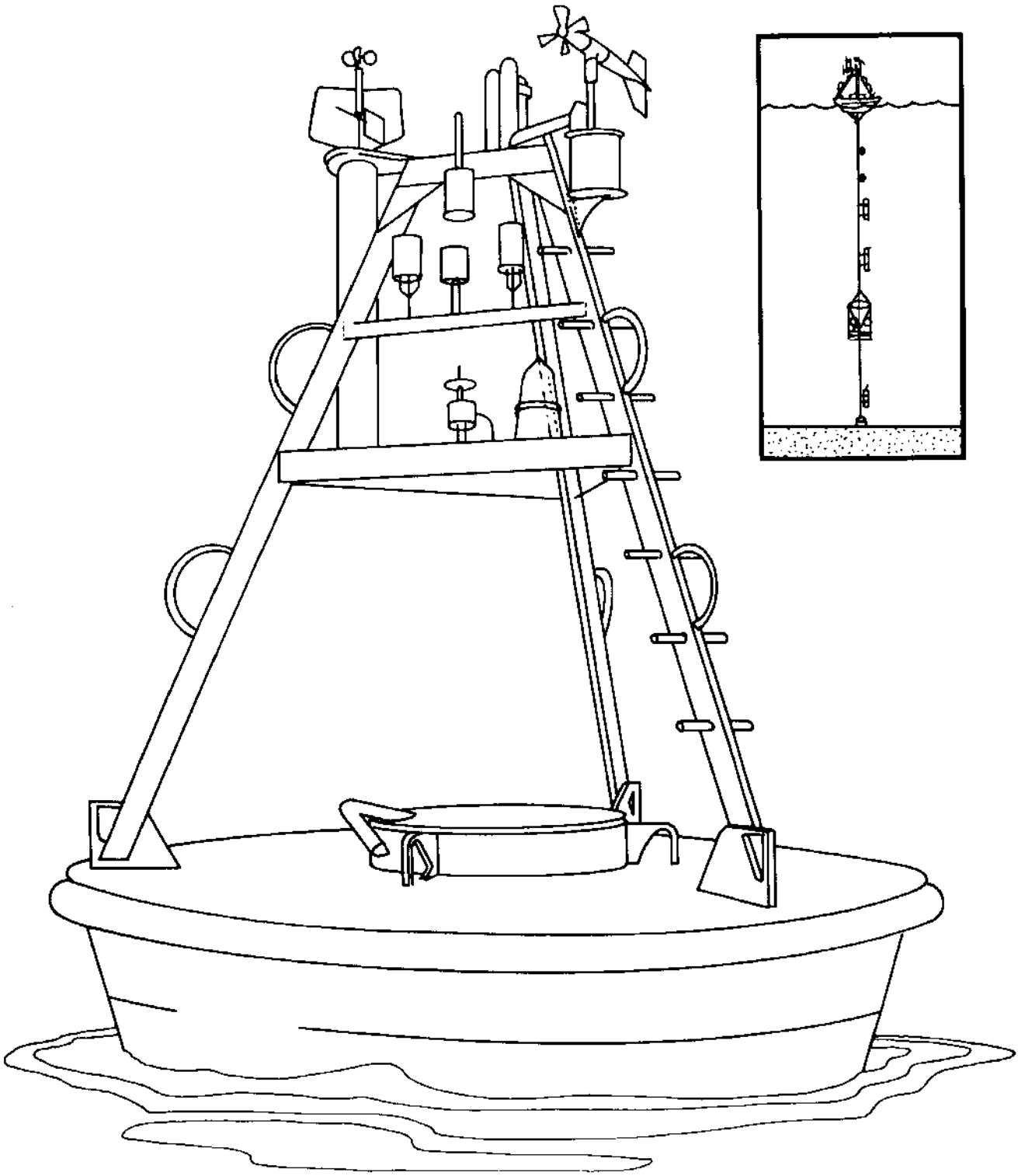


Studying the sediments found on different parts of the ocean floor helps marine geologists understand more about the past and present of the area. They use **sediment traps** to collect particles settling from the surface of the ocean to the seafloor. Many of the sediments, like mud, sand, or clay come from land and were carried to the ocean by rivers, streams, or winds; some started out in other parts of the ocean but were moved around by currents or waves.



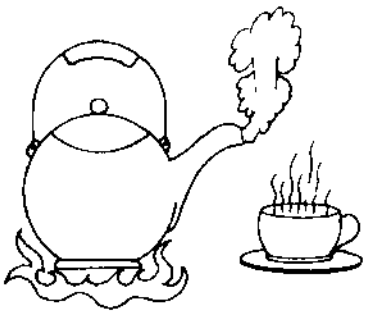
Some marine geologists study the movement of sediment along the coast. Have you ever seen pictures of houses built near the ocean that fell into the water after a big storm? One of the reasons this happens is due to **erosion.** Erosion by waves, winds, tides, and currents changes the way the land looks. Usually it is a gradual process and can take so long that we may not even notice a change.

Waves, winds, and currents also deposit sediment to form **beaches** and **dunes**. Often, the sand forming beaches along one part of the coast is supplied by the erosion of the sea cliffs at another part. Prevention of sea cliff erosion can remove the source of sand for beaches and dunes and cause them to erode.

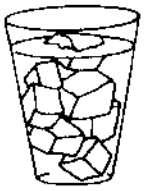


We have probably all seen **buoys** floating in the water — in swimming pools, lakes, or the ocean. Did you know that some buoys are specially designed and equipped by researchers to help scientists measure waves, currents, and weather? Buoys can be placed in remote locations to automatically record weather data and the surface temperature of the water. These measurements are important to **marine meteorologists** who study the oceans' effects on climate and weather. Oceanographers use both the weather and ocean data from buoys to study how the wind, sun, and rain create ocean waves and currents.

LIQUID

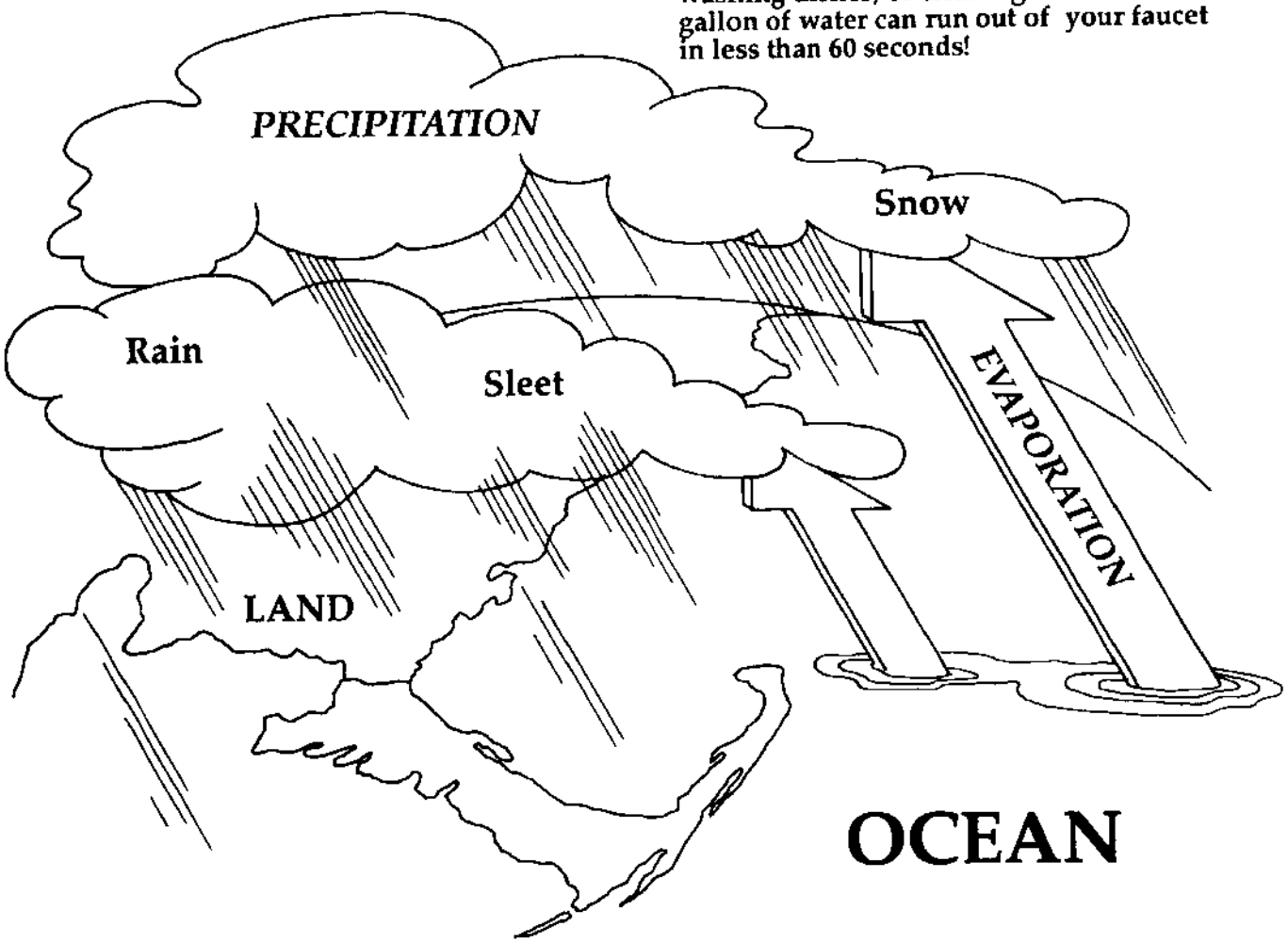


GAS

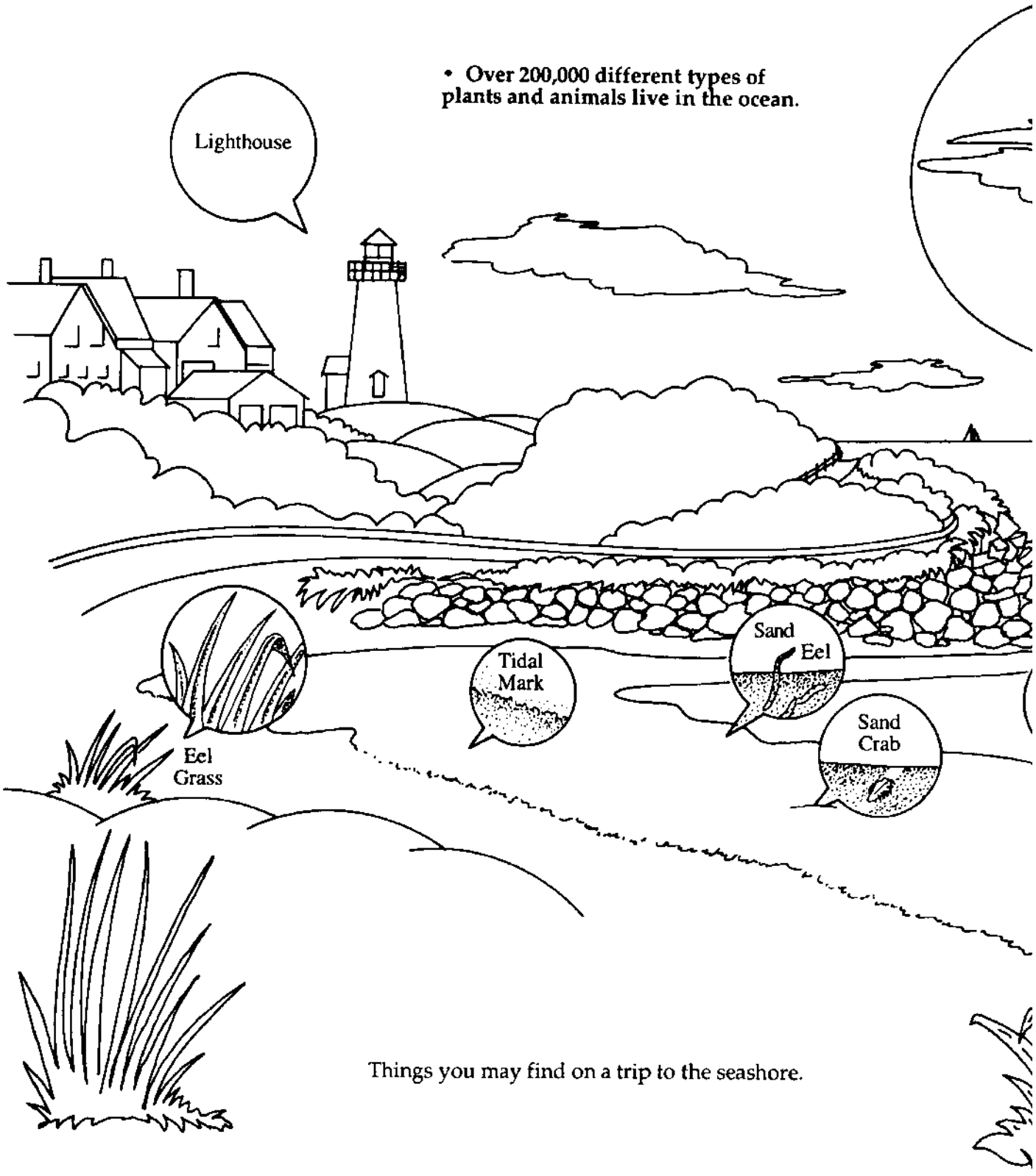


SOLID

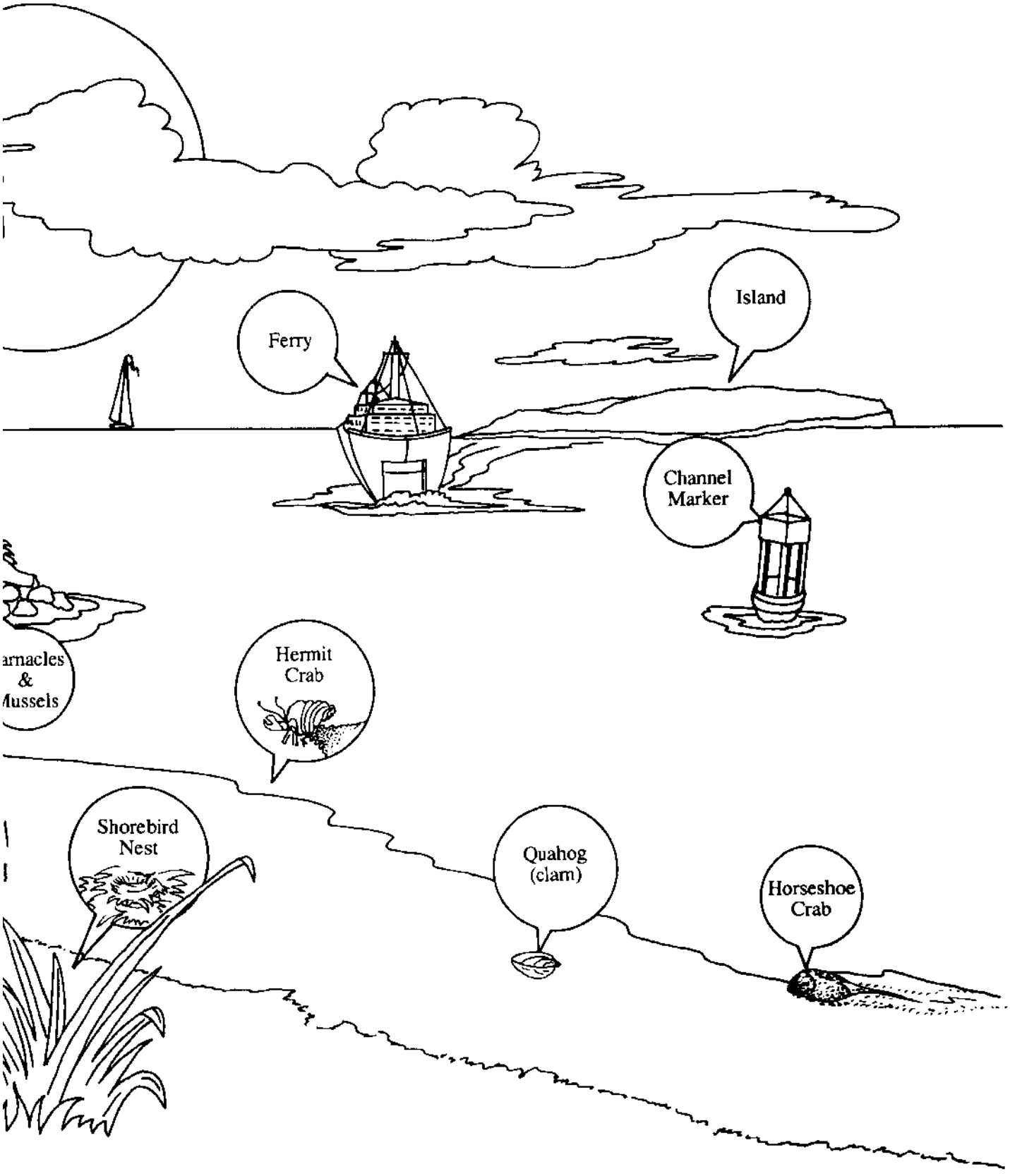
• **Turn off the water when it's not actually in use, like when you are brushing your teeth, washing dishes, or cleaning foods. A full gallon of water can run out of your faucet in less than 60 seconds!**

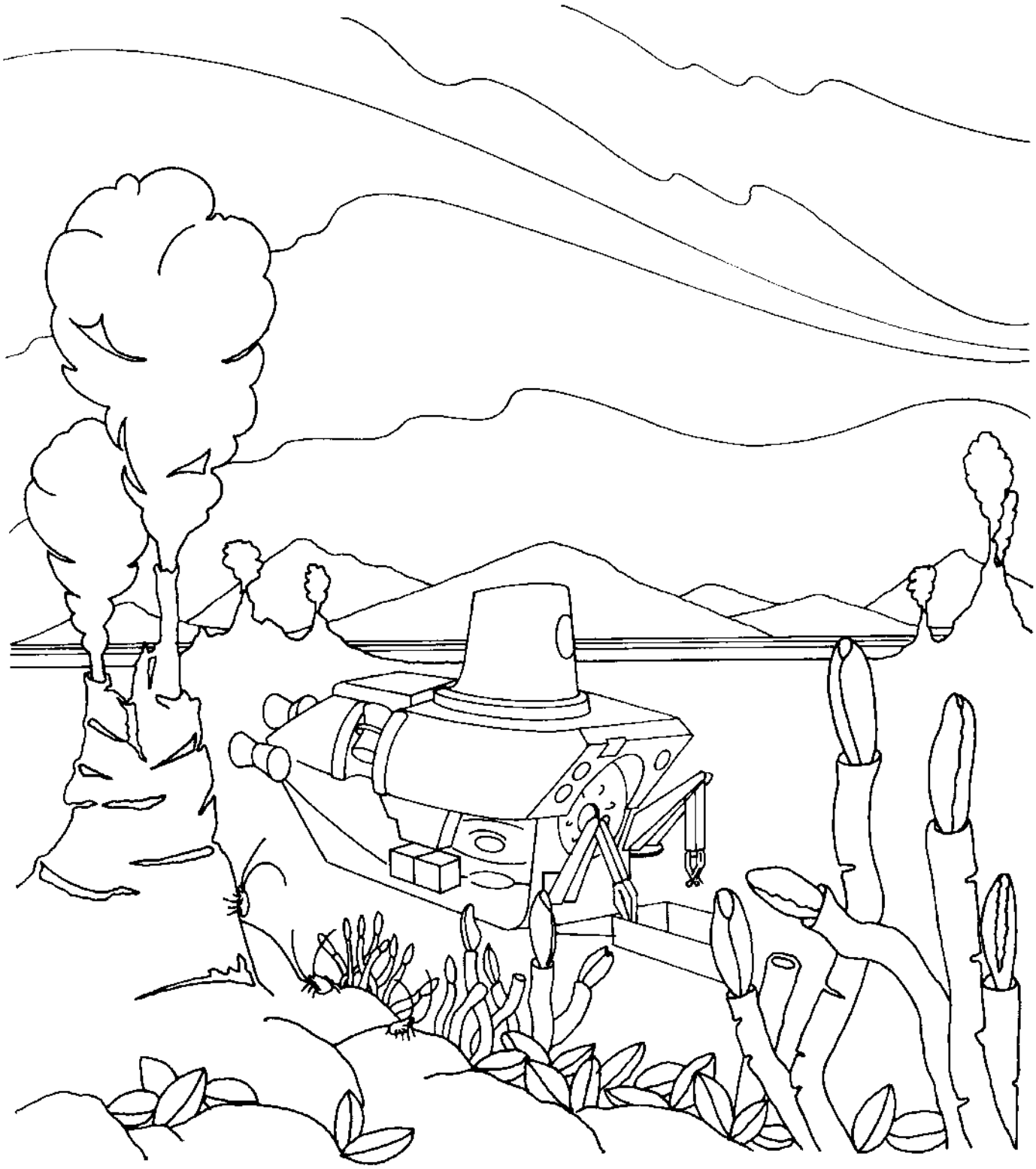


Water can be in the form of a liquid, a **gas** (water vapor), or a solid (ice). The process that water goes through to change from one form to another is called the **hydrologic cycle**. Almost all of the water that rains on land is water that has **evaporated** from the surface of the ocean. In fact, the oceans hold 97% of the Earth's water supply; the remaining 3% is freshwater. Scientists are studying how water is carried by the **atmosphere** and ocean and how the hydrologic cycle affects ocean circulation and climate.



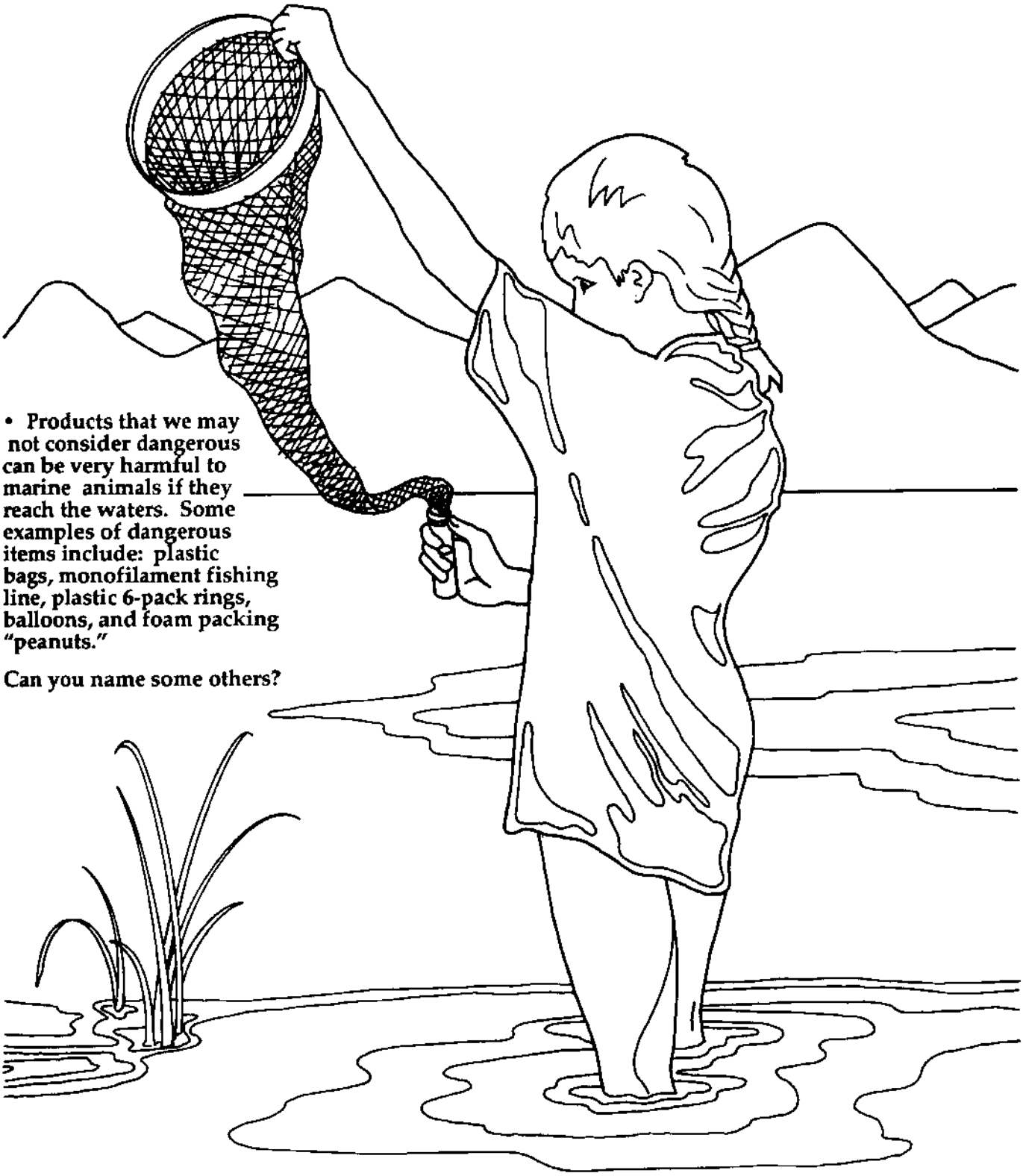
Things you may find on a trip to the seashore.


Ferry
Island
Channel
Marker
arnacles
&
Mussels
Hermit
Crab
Shorebird
Nest
Quahog
(clam)
Horseshoe
Crab



Oceanographers discovered unusual marine creatures living at hydrothermal vents. Red-plumed tube worms, never seen before, thrive beside giant clams, mussels, crabs, shrimp, and **sponges**. The creatures that live near the vents are very different from the ones we usually see because they live in complete darkness and the water is nearly freezing.

Sea floor life is especially rich at vents. Why is this? The chemistry of vent water provides energy for **bacteria** to grow **(chemosynthesis)** in the same way that sunlight provides energy for plants to grow **(photosynthesis)**. The bacteria serves as the food supply for vent animals.

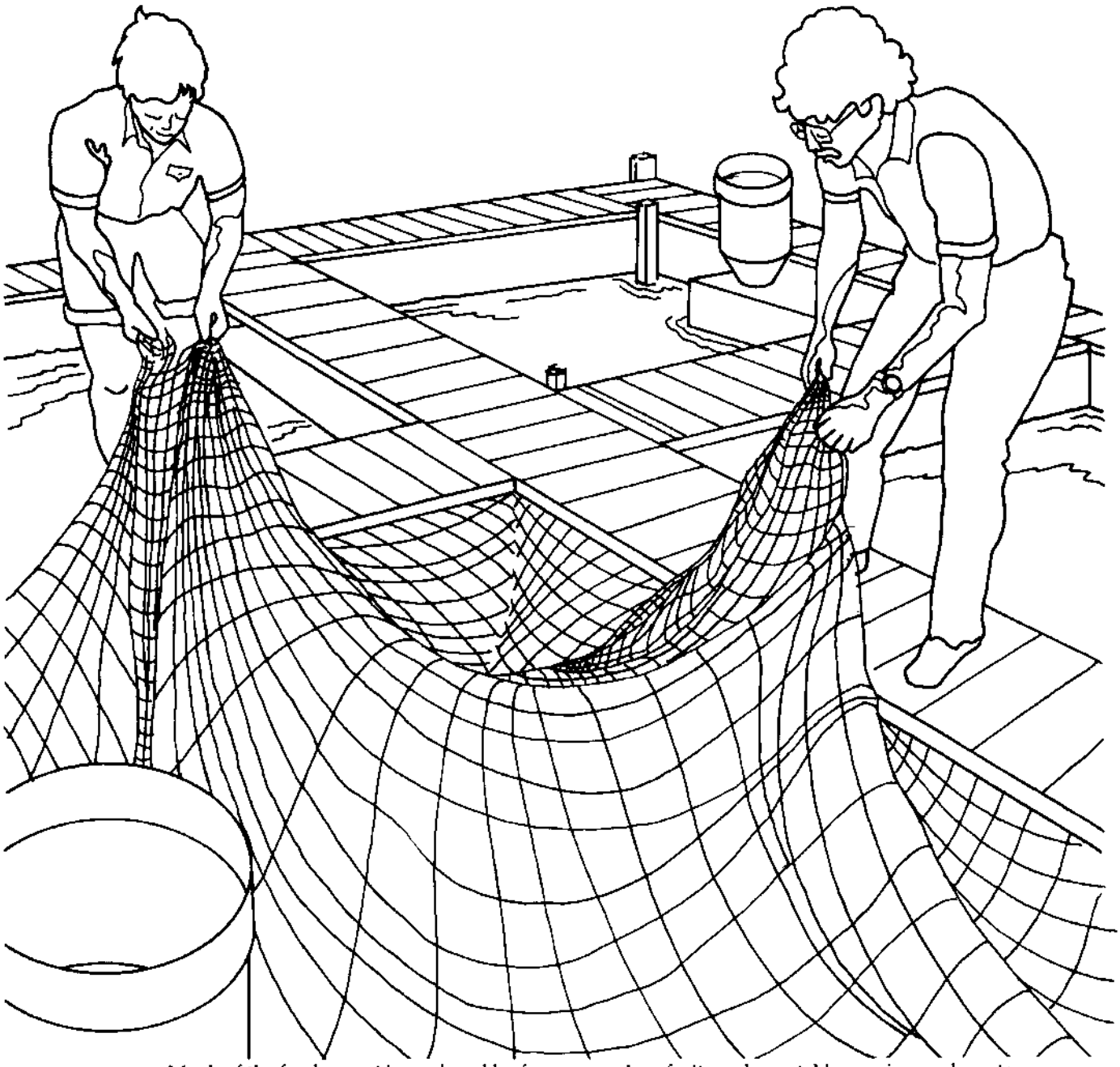


• **Products that we may not consider dangerous can be very harmful to marine animals if they reach the waters. Some examples of dangerous items include: plastic bags, monofilament fishing line, plastic 6-pack rings, balloons, and foam packing "peanuts."**

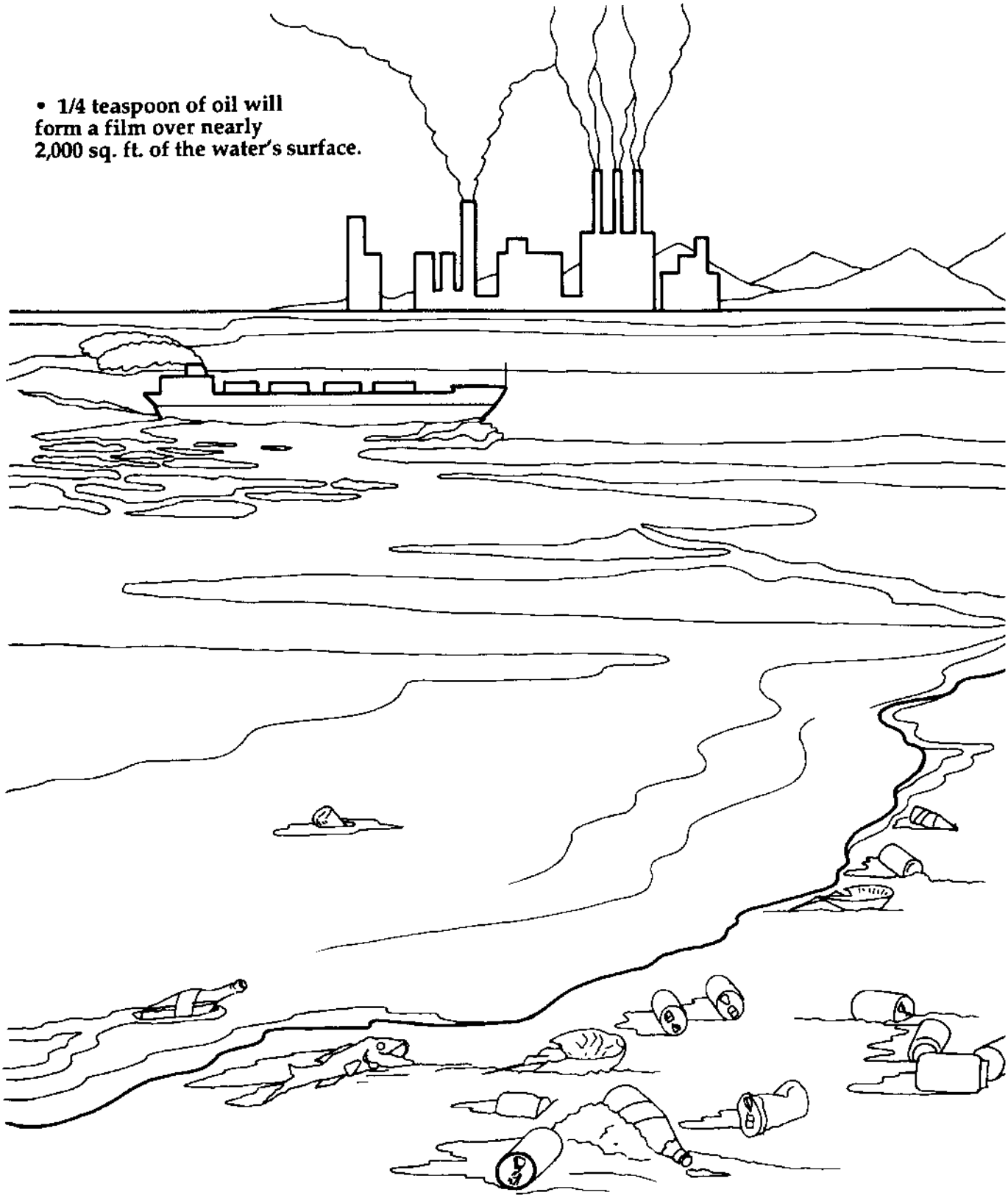
Can you name some others?

Students come to the Woods Hole Oceanographic Institution from all over the world to study ocean sciences, such as marine biology, marine chemistry, geology and geophysics, physical oceanography, and ocean engineering. While here, the students work with experienced scientists on research projects. Sometimes this involves going out to sea, conducting experiments in the laboratory, doing fieldwork, or creating computer models. At the end of their studies here, most of the students earn a graduate degree in oceanography.

• **In 1991, the average amount of fish and shellfish eaten by each person in the United States was 14.9 pounds. Of that total, 15%, or 2.24 pounds, was "farmed," or produced by aquaculture.**

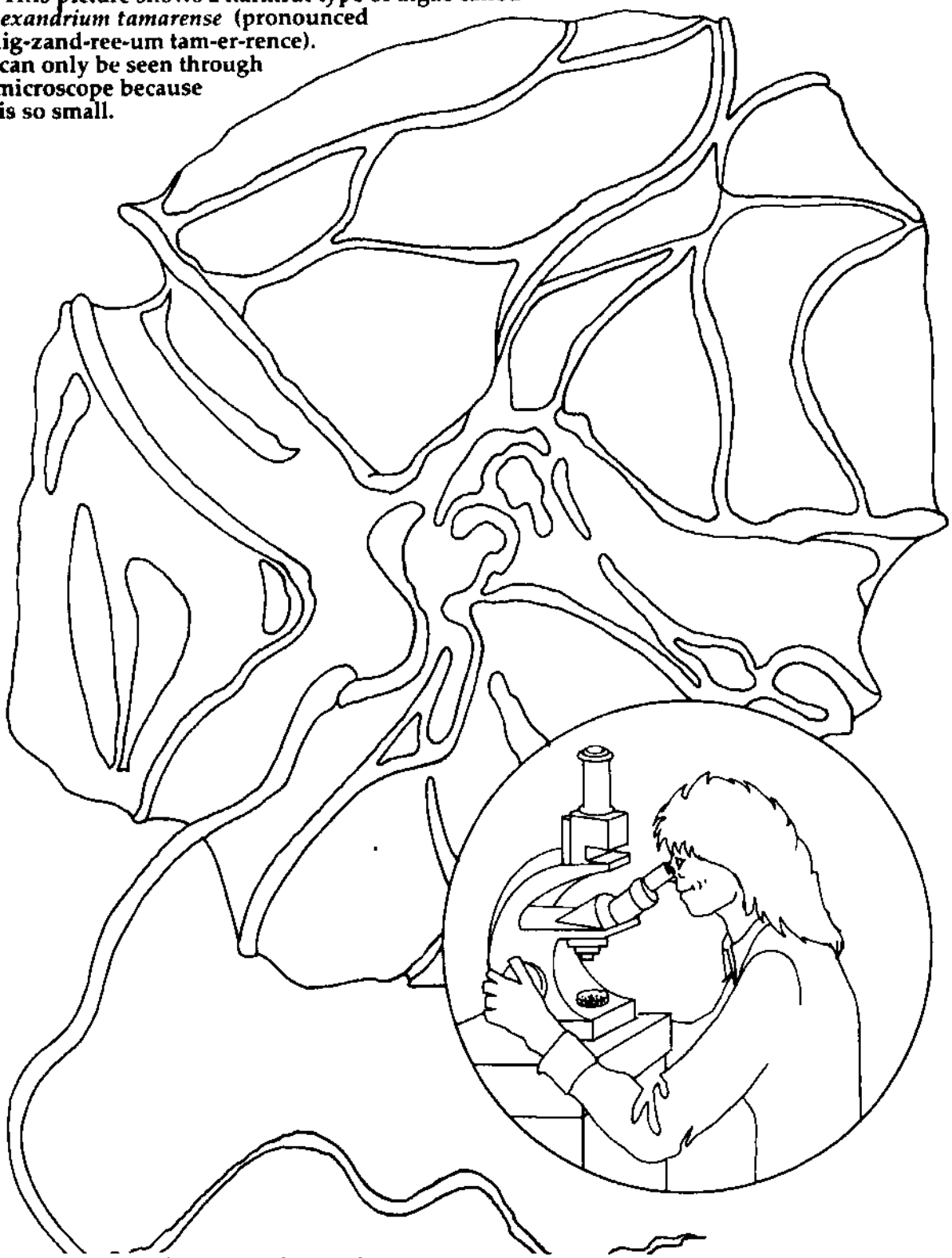


Much of the food we eat is produced by farmers, such as fruits and vegetables, grains, and meats. But did you know that there are also farmers that raise fish and shellfish for us to eat? Because the **stocks** of many of the popular kinds of fish and shellfish we eat, like salmon, trout, oysters, clams, and scallops are decreasing in number, fish farming is becoming more important. The scientific names for fish farming are **aquaculture** and **mariculture**.

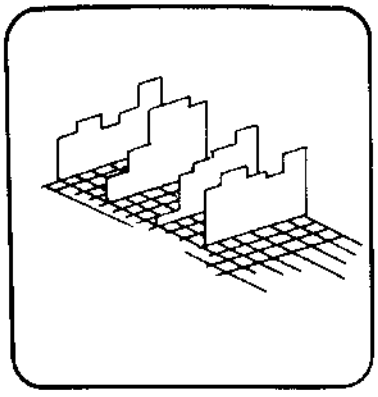


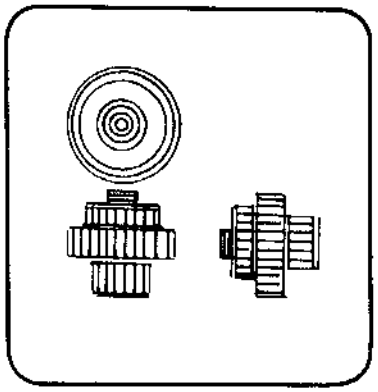
Many of the products we use, for example, toothpaste, shampoo, dishwashing soap, gasoline for the car, fertilizer for the garden, contain chemicals. A few of these chemicals can cause problems when they get into the oceans, especially the ocean near the coast. Even in small amounts, some of these chemicals can be very harmful, especially to the animals and plants that live in the ocean. Chemical oceanographers study water pollution from chemicals that come from factories, homes, gardens, shopping malls, and other places. They also study how the ocean, land, and atmosphere exchange chemicals and make our planet Earth a livable place.

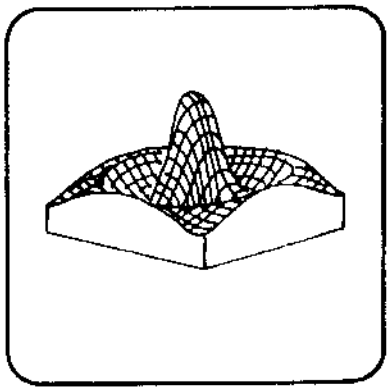
• This picture shows a harmful type of algae called *Alexandrium tamarense* (pronounced Alig-zand-ree-um tam-er-rence). It can only be seen through a microscope because it is so small.



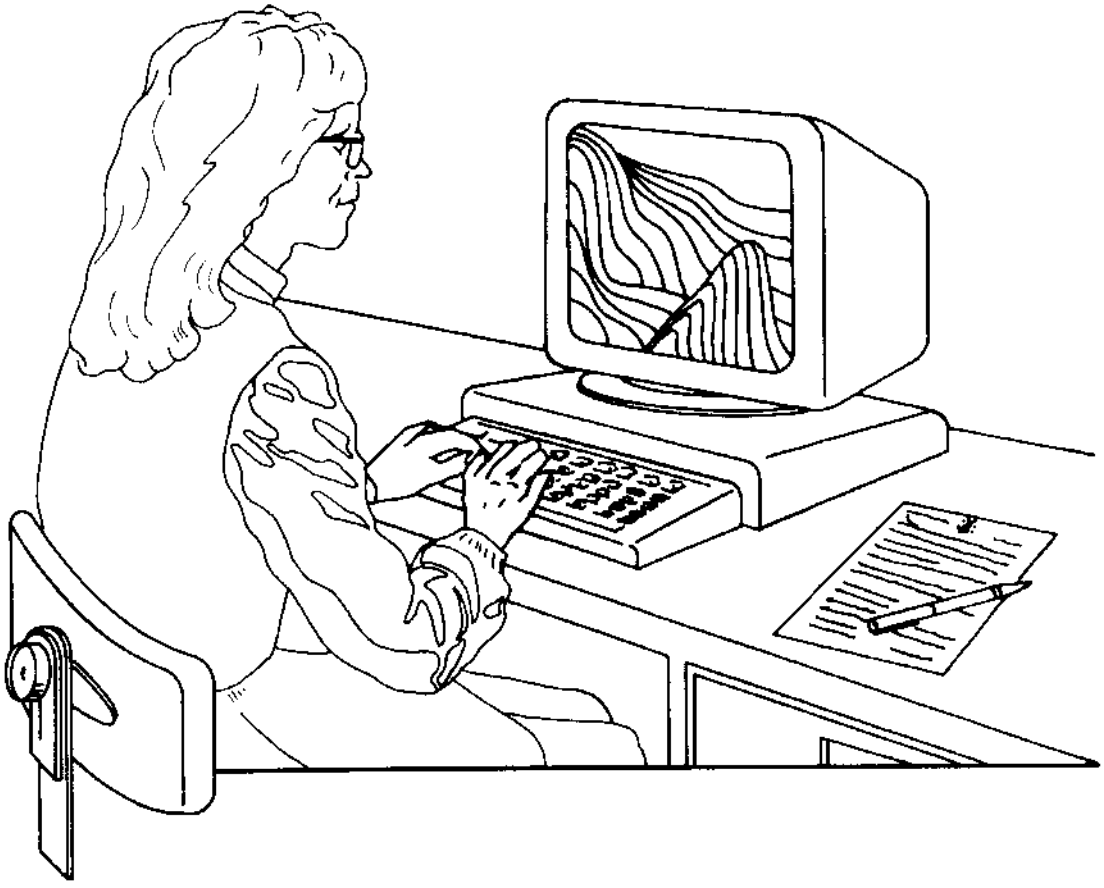
Like most plants, water plants prefer sunshine and warmth. Tiny marine plants called **algae** reproduce by dividing, so that one cell becomes two cells, two cells become four cells and so on. Scientists refer to the rapid growth of algae as "algal blooms." Algae are moved through the oceans by currents and, though thousands of algae species are harmless, dozens of species can be harmful, or toxic, to fish and shellfish who feed on the algae, or to animals including humans who eat the fish or shellfish. Scientists all over the world are trying to learn more about these harmful blooms of algae, known as **red tides.**



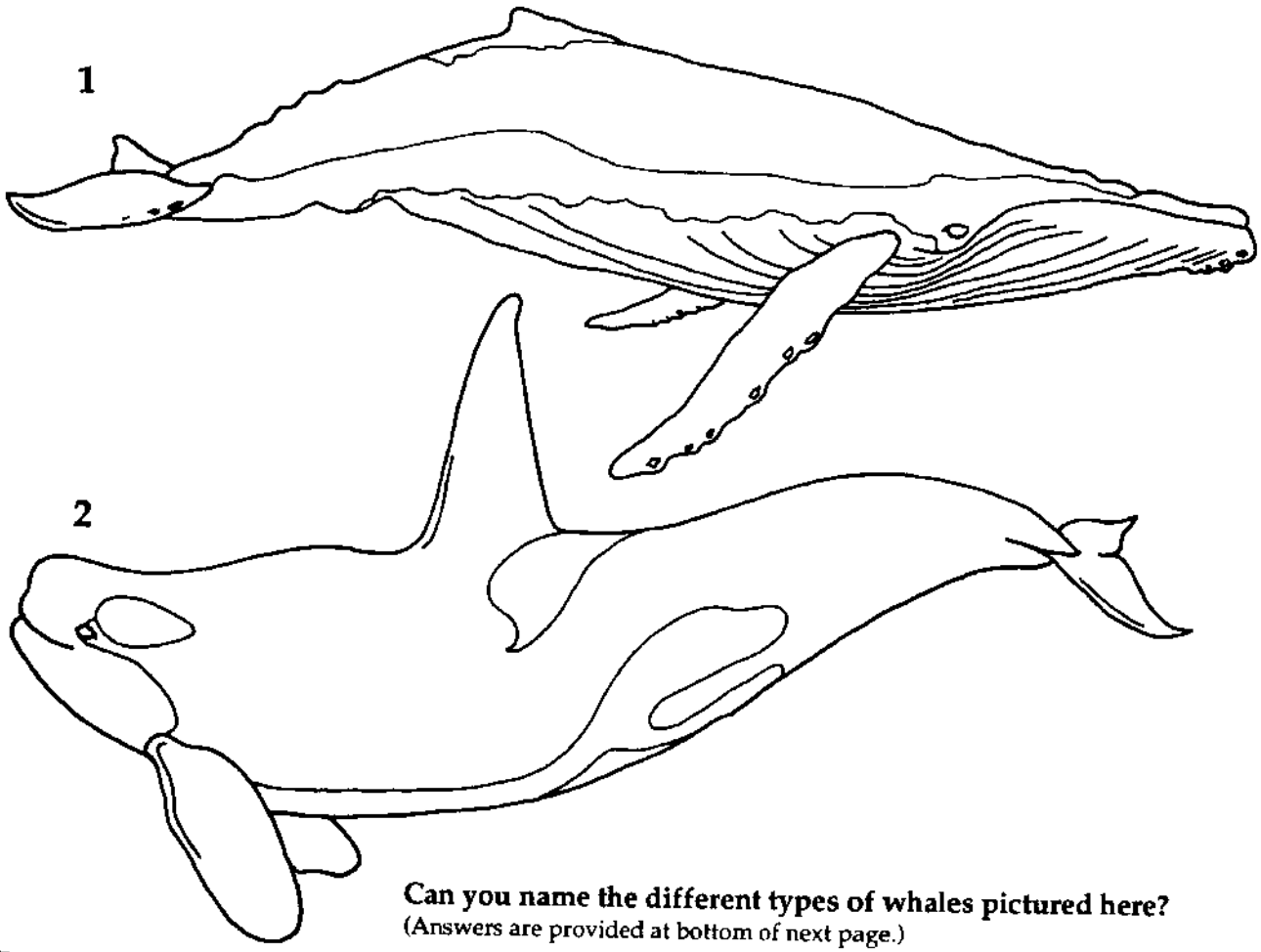




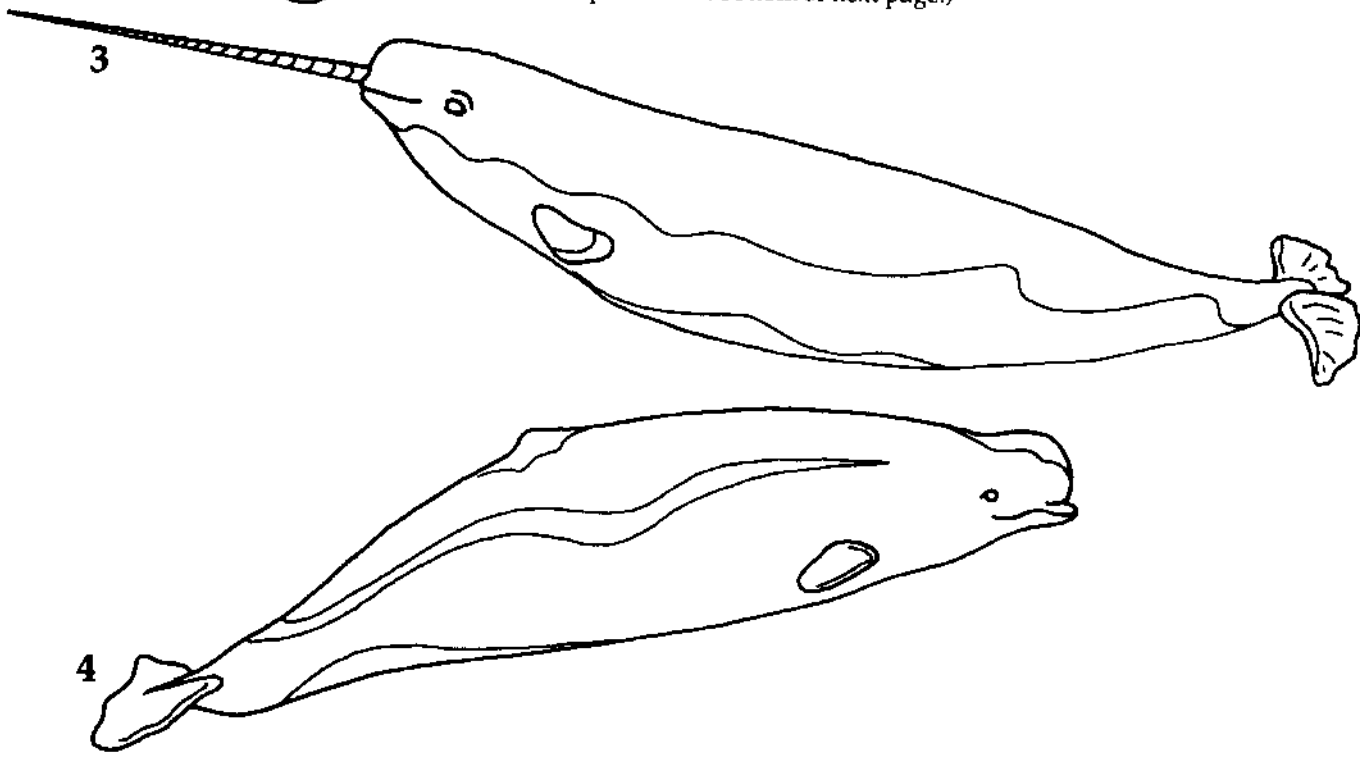
• Modern computers make it possible for scientists to do calculations that were once impossible to do by hand. Computers have also allowed scientists to create models to solve many problems that would have taken months or even years to do by hand.



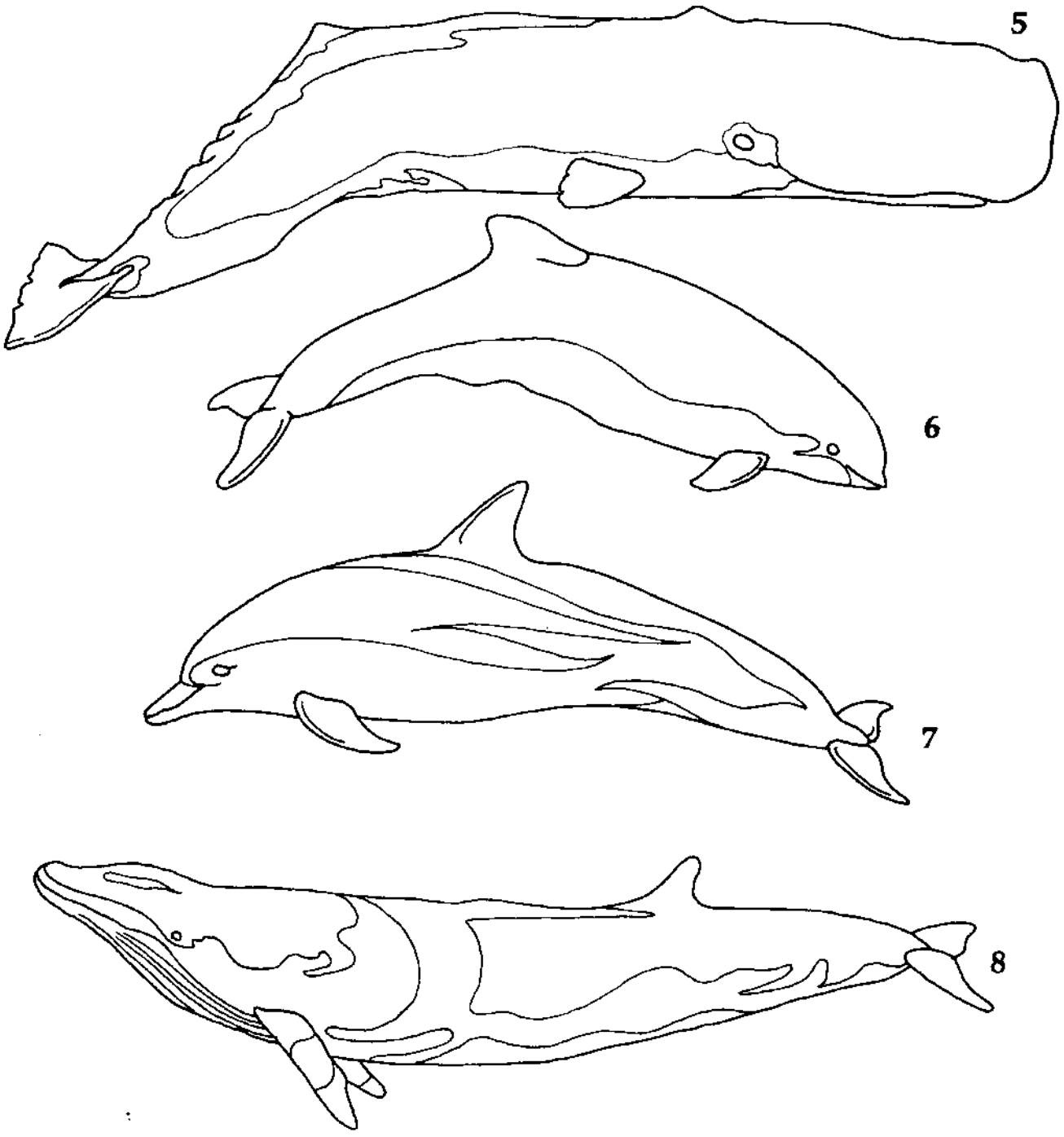
Have you ever put together a model airplane or car? looked inside a doll house? visited an aquarium? These are all examples of models — a smaller, simpler version of something that may actually be much larger or harder to use or understand. For example, an aquarium could be considered a model of a lake or a specific part of the ocean, depending on what type of plants, fish, and water you put in it. Scientists also use computers to create models that help them understand how things work and to help them make **predictions** about the way the ocean works. Two examples of things that scientists use computer models for are: understanding how pollution may move around in a bay once it is introduced, and the travel patterns of whales as they migrate from feeding grounds to breeding grounds season to season.



Can you name the different types of whales pictured here?
(Answers are provided at bottom of next page.)

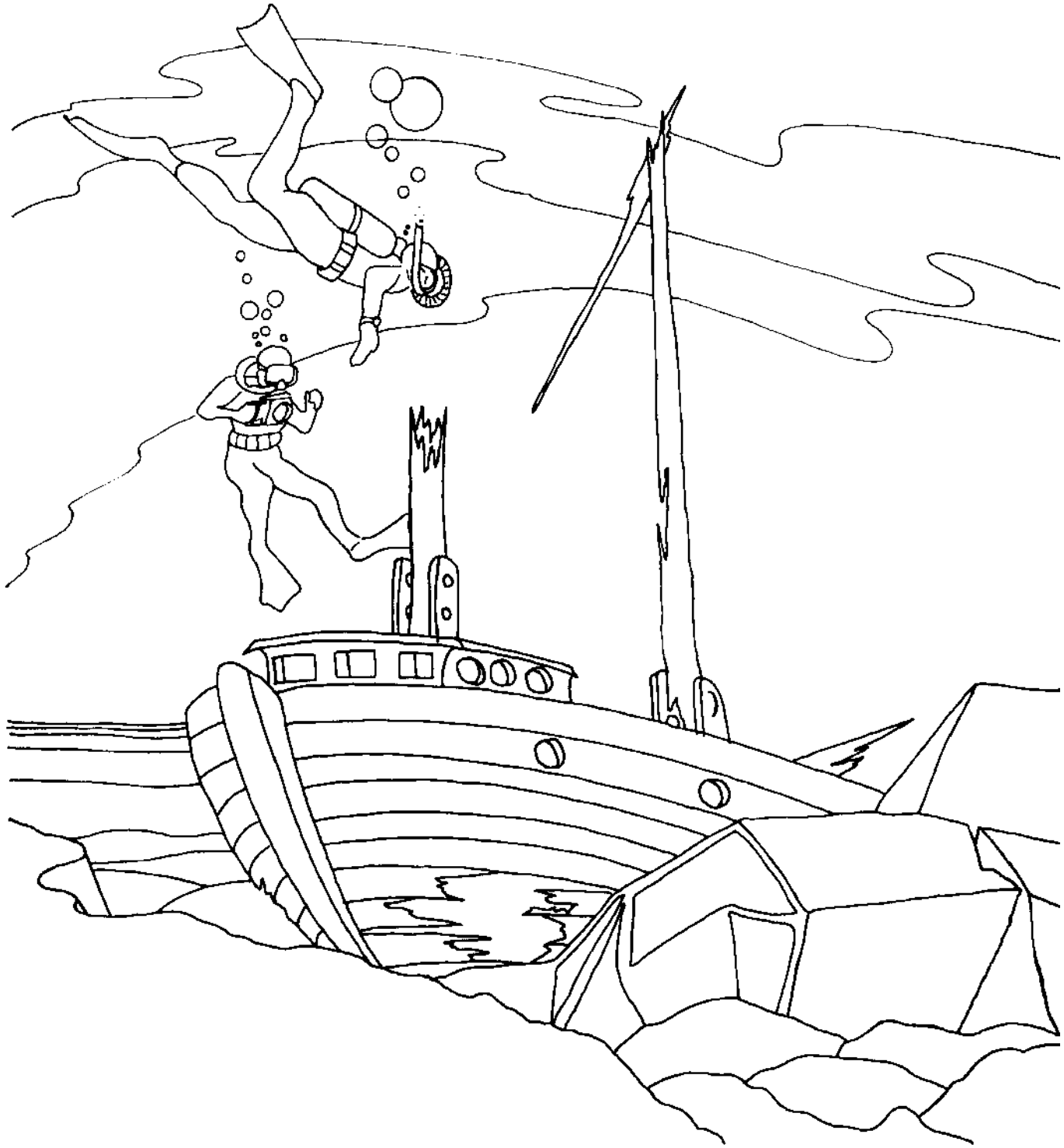


- **The whale family consists of many different species, including porpoises and whales. Marine mammals breathe air like we do.**



Animals have ways of talking to each other, or communicating, just like we do. This can be done by speaking, or using signs or body postures. Marine biologists study the communication and sounds of **marine mammals** such as whales, porpoises, and dolphins; this science is called marine mammal bioacoustics. The scientists at WHOI study the sounds made by many of the whales pictured here.

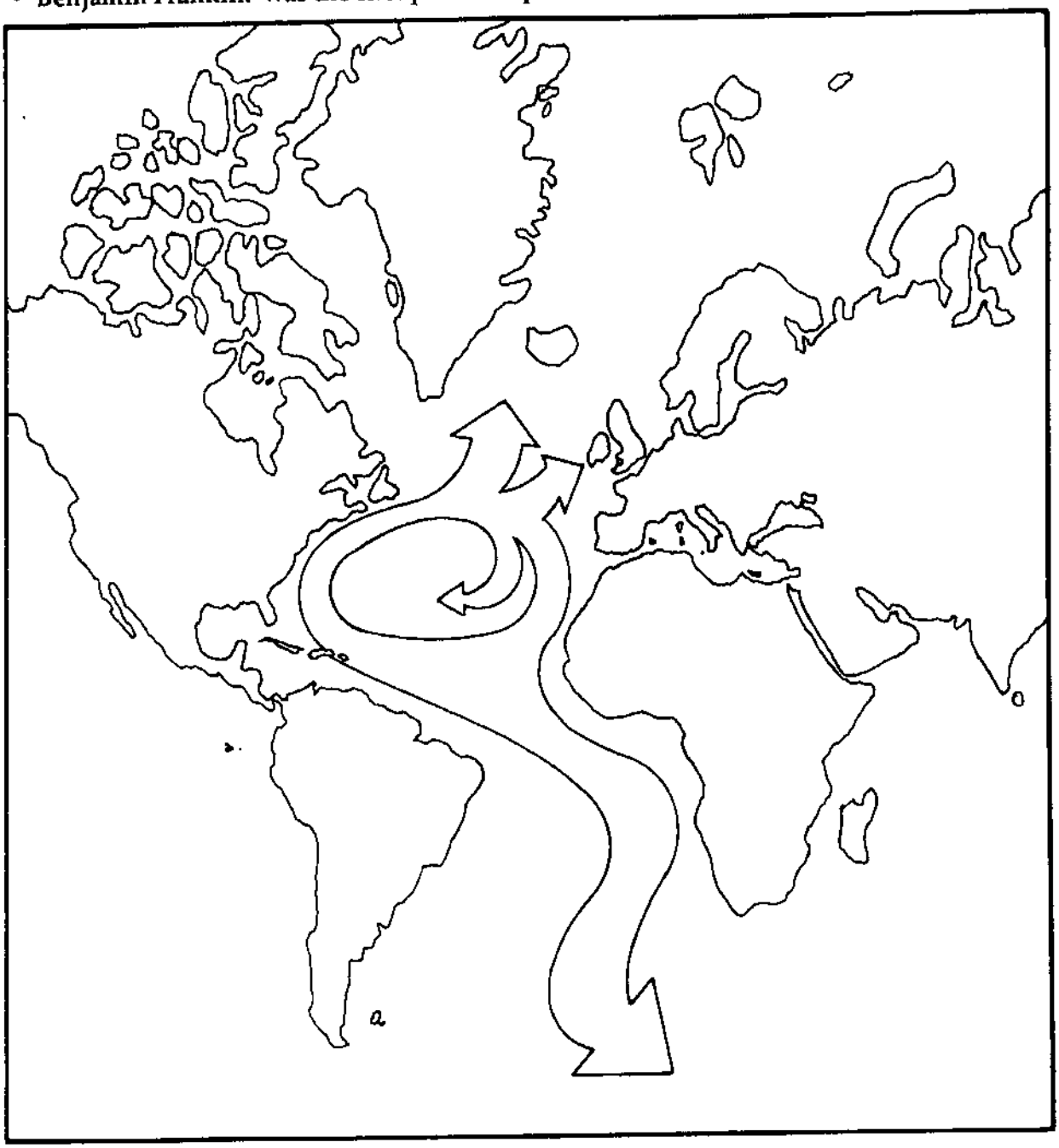
1) Humpback Whale 2) Killer Whale 3) Narwal Whale 4) Beluga Whale
5) Sperm Whale 6) Harbor Porpoise 7) Common Dolphin 8) Minke Whale



Ocean engineers have constructed robots that serve as their eyes and ears underwater. These robots have helped oceanographers search for, discover, and explore historic shipwrecks such as the *R.M.S. Titanic*, a passenger liner, and the *U.S.S. Monitor*, a U.S. Civil War gunship. Marine archaeologists study historic shipwrecks and ancient coastal villages that are now **submerged**. Using underwater robots, marine archaeologists can learn about ancient cultures and ways of life without disturbing the shipwreck or the village.

Once a shipwreck is discovered, many questions arise: Who owns the historic shipwreck, and what should be done with it? How can we make it so that lots of people can learn about and enjoy historic shipwrecks? Working with oceanographers and marine archaeologists, scientists in the field of **marine policy** seek answers to these questions.

- **Benjamin Franklin was the first person to plot the course of the Gulf Stream.**



Physical oceanographers study the movement of the oceans and the things that cause motion, such as winds, waves, currents, and tides. The **Gulf Stream**, which is in the Atlantic Ocean, is one of the most important examples of ocean movement ever discovered. It acts like a gigantic conveyer belt, like the ones we see at the grocery store that move the groceries along the counter. The Gulf Stream circulates water from one part of the ocean to another. By bringing the warm water found near the equator to the colder areas and the cold water to the warmer areas, the Gulf Stream also helps to warm or cool the air temperature.

We all know that the ocean is salty, but did you know that the ocean also contains elements, gases, chemical compounds, and minerals? Some people compare the ocean to a "chemical soup" because it contains so many "ingredients." Chemical oceanographers and **marine geochemists** study seawater and ocean muds to learn more about the ocean's resources, like food (fish, shellfish, seaweed) and energy (underwater deposits of oil and minerals).

WORD SEARCH

r e m o t e l y o p e r a t e d v e h i c l e s p
i r s t n e m i d e s e b a l g a l b l o o m s h
d o p e o t r e h c l d s e h c n e r t n a e c o
g h e m r l a t m o s p h e r e i t p n e l g a t
e r o s i o n o r a o l c q y a v h a l g a e d o
s p f t b y c e s n l u a q e w l s h a m q n i s
s t a c k n q u g h w m i n e r a l s c s u r d y
t w g e o u t e r e s e l o m a l e g a o a s h n
s a g s a d s e d i t d e r o e s e r p a c n d t
i t e t e l e r o d i t o x i c n i m l g u o y h
g e o c e a l s t o y u g e l e p o u n b l i n e
o r e n c h b o k c p b u o y s c n s u b t t s s
l p s l a c i m e h c e h m e l n e t s e u c r i
o o b n s o s o s e d w i l a t e r s m a r i e s
e l c i a s r c r e d o a c o a s t l i n e d k e
g l h m p t e d i c y r i r e s d o m n e s e o s
e u e e l e m e n t s m o i d c o x n e n g r m e
n t l c a s b g s s e s e d i m e n t t r a p s t
i i t f o l u y s h m t o s n i r a s e d o m k a
r o n z s a s e c n o d a e t p r m a r i t o c l
a n a m e t i r v y d h n s n o l i m p e t s a u
m t n c a c r y n l e p d m p o c l e t a m i l c
s w a s e u b e l c l i t a m c e k y b e y i b r
i l u p f x i c a h s w v e r t o m s h p m j t i
b o s t n e v l a m r e h t o r d y h l l o m h c

For Answers, See Page 32

Algae
Algal blooms
Alvin
Atmosphere
Aquaculture
Black smokers
Buoys
Chemicals
Chemical compound
Circulates
Climate
Coastline
Cores
Elements
Equator
Erosion
Evaporate
Gases
Gulf Stream
Guyots
Hydrothermal vents
Marine geologists
Minerals
Models
Photosynthesis
Predictions
Red plumed tube worms
Red tides
Remotely operated vehicles
Ridges
Sediment traps
Sediments
Species
Sponges
Stocks
Submersibles
Toxic
Water pollution

Glossary

algae - Unicellular or multicellular simple plants that have no vascular tissue and therefore no leaf, stem, or root systems.

aquaculture - Farming of the ocean or freshwater, whereby organisms, such as fish, algae, and shellfish, are grown under controlled conditions. Includes mariculture.

atmosphere - The envelope of gases, vapor, and air-borne particles surrounding the earth.

bacteria - Minute organisms which are primarily responsible for decay.

bathymetry - Measurement of depths of water in the oceans to determine bottom contours.

beaches - Formed along the coast when waves, winds, and currents deposit sediment.

black smokers - Smokestack-like structures composed of sulfide and sulfate minerals which cap seafloor hydrothermal vent sites. "Black smoke" refers to the abundance of dark particulates that form when extremely hot (350°C) hydrothermal fluid rapidly exits the chimney opening and mixes with cold (2°C) seawater.

buoys - Anchored objects floating on the top of the water, some of which can automatically record weather data.

chemical oceanographers - Those who study the elements in the oceans which compose sea water and sediments.

chemosynthesis - Synthesis of organic compounds (as in living cells) by energy derived from chemical reactions.

circulation - The movement of masses of water on the surface or in the depths of the ocean.

climate - Weather conditions prevalent in an area over a period of time. Weather conditions include temperature, rainfall, sunshine, wind, humidity, and cloudiness.

cores - Cylindrical samples of soil, ice, snow, or rock obtained by a hollow tube (corer) driven into the material.

currents - Horizontal movement of water. Currents can be either tidal (caused by gravitational interactions among the sun, moon, and earth) or nontidal (include the permanent currents in the ocean's general circulatory systems).

data - Information from which conclusions are formed.

dunes - Formed along the coast when waves, winds, and currents deposit sediment.

elements - Chemical substances that cannot be decomposed into simpler substances by chemical reactions.

energy - Major sources include: fossil fuels (coal, natural gas, oil), hydropower, nuclear, solar, and wind.

erosion - The process by which the earth is worn away by waves, winds, tides, and currents.

evaporate - Convert to a gaseous state or vapor.

gas - One of the three states of matter; the others are solid and liquid.

Gulf Stream - A North Atlantic Ocean current running northeastward off the east coast of the United States. Part of the oceans' general, surface circulation.

guyots - Flat-topped, underwater mountains.

hydrologic cycle - Process water goes through to change from one form (ice) to another (water) to another (gas).

hydrothermal vents - Areas on the ocean floor where mineral-rich, hot water is escaping from the Earth's interior.

ketch - A two-masted sailing vessel.

manipulator arm - A mechanical device used to collect samples in the ocean.

mariculture - Cultivation of plants and animals in a controlled saltwater environment.

marine biologists - Those who study marine plants and animals. They are interested in marine organisms' development, interrelationships, and adaptations to and interactions with the environment.

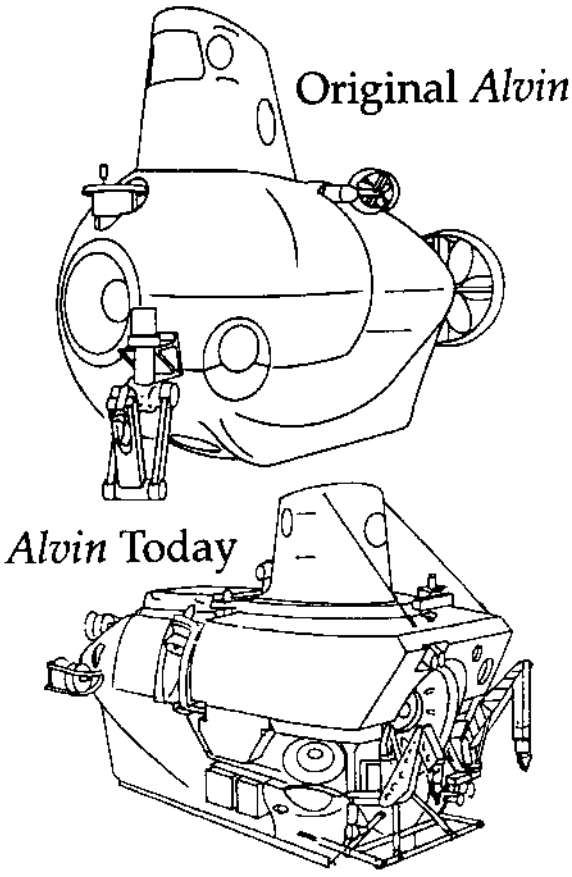
marine geochemists - Those who investigate the chemical composition of sea water and its interaction with the atmosphere and sea floor.

marine geologists - Those who study the origin, structure (mountains, basins, trenches), fossil fuel deposits, and changes occurring on the sea floor.

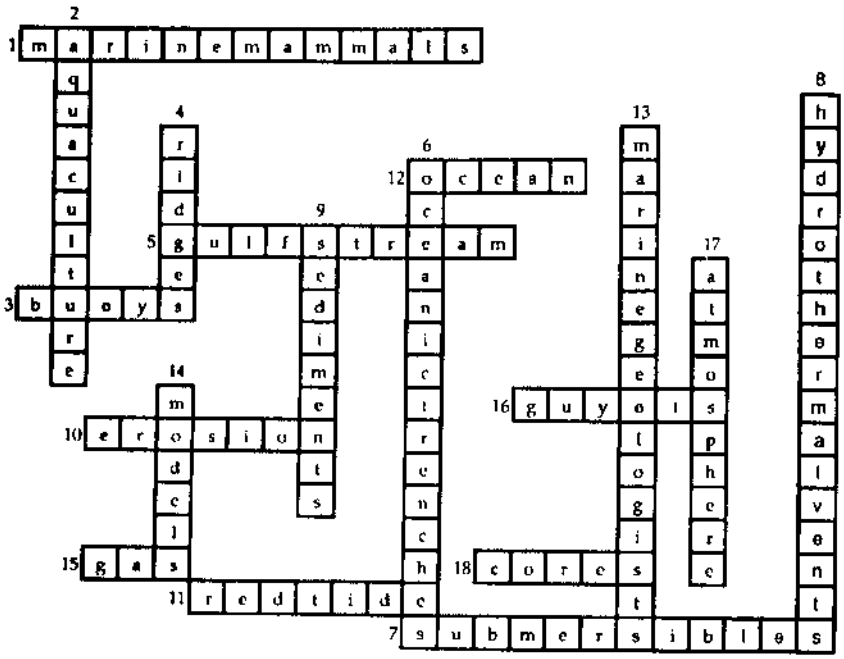
marine mammals - "Warm blooded" (that is, capable of maintaining a stable body temperature by physiological means) vertebrates having mammary glands and body hair, and give birth to live offspring. Examples of marine mammals include whales, seals, sea lions, sea otters, and walruses.

marine meteorologists - Those who study the oceans role in influencing regional and global weather changes by analyzing data sent to them by ships, weather buoys, aircraft, and satellites.

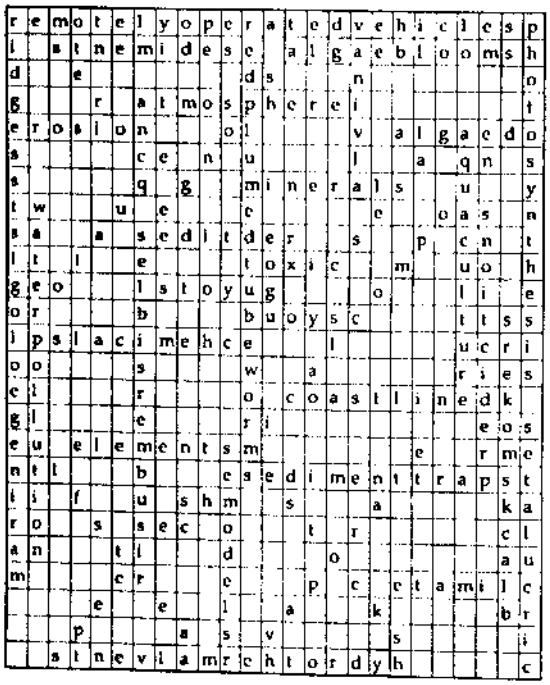
marine minerals - Minerals found in the ocean.
marine policy - The study of the wise use of the ocean.
minerals - Naturally formed chemical elements or compounds having a definite chemical composition and, usually, a characteristic crystal form.
oceanic trenches - Long, narrow, and deep depressions of the ocean floor that have relatively steep sides.
oceanographers - Those who specialize in the study of the oceans.
oceanography - The science involving the study of the ocean.
photosynthesis - The process that produces plant tissue in green plants. The process requires sunlight, carbon dioxide, water, and chlorophyll (the green coloring matter in plants). One of the basic support systems for life on earth, photosynthesis returns oxygen to the atmosphere and removes carbon dioxide. Animals use the oxygen and give up carbon dioxide as a waste product.
physical oceanographers - Those who investigate the physical dimensions of the ocean such as temperature, density, wave motions, tides, and currents. They also study the ocean's interactions with the atmosphere which influence weather and climate, the transmission of light and sound through water, and the ocean's interactions with its boundaries at the seafloor and the coast.
predictions - To foretell on the basis of observation, experience, or scientific reason.
red tides - Dense accumulation of tiny, single-celled marine plants that discolor coastal waters.
remotely-operated vehicles (ROVs) - Unpiloted submersibles that are attached to a support, or mother, ship by a long cable and maneuvered by remote control.
resources - Anything used to contribute to the cultures of man.
ridges - An interlocking series of continuous undersea mountain ranges.
SCUBA - Self Contained Underwater Breathing Apparatus. Allows divers to breathe compressed air while swimming underwater.
salinity - Saltiness of the water measured in parts per thousand (ppt). The average salinity of the sea is 35 ppt, which means thirty-five pounds of salt per 1,000 pounds of water.
satellites - Natural or man-made objects that collect data and orbit around the moon or one of the planets.
sediment traps - Devices used to collect particles settling from the surface of the ocean to the seafloor.
sediments - Loose material deposited by waves, rivers, glaciers, or wind that settles on the ocean floor.
species - A specific type or plant or animal.
sponges - Marine invertebrates characterized by a porous structure and a skeleton of interlocking, thornlike fibres.
stocks - An accumulation of something which is maintained as a constant source of supply.
submerged - Located beneath the surface of the ocean.
submersibles - Small vessels occupied by researchers intended for detailed study of small areas or the movement of equipment on the sea bottom that can dive and remain submerged for long periods. They are designed to be easily moved, and are battery-powered and capable of withstanding the great pressure of ocean depths.
toxic - Poisonous.



Crossword Answers



Word Search-Answers



Woods Hole Oceanographic Institution

The Woods Hole Oceanographic Institution (WHOI) is a private, nonprofit research facility dedicated to expanding the frontiers of knowledge about the marine world. Its shore-based facilities are located in the village of Woods Hole and a mile and a half away, on the 200-acre Quissett Campus. The staff, which numbers about 1,000, includes scientists, engineers, technicians, graduate students, postdoctoral scholars, and visiting fellows from around the world.

WHOI's ships carry investigators throughout the world ocean to conduct highly diverse research that ranges from tracking currents and pollutants in coastal waters to examining ancient climates by measuring gases trapped in tiny air bubbles frozen in polar ice.

The three-person, deep-diving research submarine ALVIN is a testament to WHOI's leadership in deep submergence engineering. The Institution's engineers also have pioneered the unmanned Remotely Operated Vehicles (ROVs). The JASON/MEDEA ROV system developed by WHOI's Center for Marine Exploration uses fiber-optic cable to send video images to banks of television monitors aboard ship. The underwater images can be transmitted live anywhere in the world via satellite.

Most of the Institution's investigators are based in five departments: Applied Ocean Physics and Engineering, Biology, Marine Chemistry and Geochemistry, Geology and Geophysics, and Physical Oceanography. Economists and other social scientists at WHOI's Marine Policy Center assess current national and international oceanic issues, serving as a link between public policy and scientific research. At WHOI's Coastal Research Center, investigators from all departments focus on the processes underway in waters nearest our shores, the areas that are the most affected by the activities of human beings.

The Sea Grant Program at the Woods Hole Oceanographic Institution

The Sea Grant Program at the Woods Hole Oceanographic Institution supports research, education, and advisory projects to promote wise use and understanding of ocean and coastal resources for the public benefit. It is part of the National Sea Grant College Program of the National Oceanic and Atmospheric Administration (NOAA), a network of 29 individual programs located in each of the coastal and Great Lakes states to encourage cooperation among government, academia, and industry. Sea Grant strives to accomplish this by linking research, outreach, and education.

The WHOI Sea Grant Program is an important part of the Institution's research effort and has involved researchers from all parts of the Institution. The results of these efforts have yielded, over the past two decades of the WHOI Sea Grant Program, over six hundred publications, including technical reports, scientific publications in refereed journals, books, theses, maps, and other literature.

The Marine Advisory Program of WHOI Sea Grant

The Marine Advisory Service (MAS) of the National Sea Grant College Program provides outreach and technology transfer for Sea Grant research results. In short, MAS staff take complex information and teach people how to use it to solve environmental, resource or conservation problems. The MAS is a major component of the tripartite nature of the National Sea Grant College Program -- research, education, and advisory service.

The Communications/Public Outreach and Education Program of WHOI Sea Grant

The goal of the WHOI Sea Grant Program's communications and outreach effort is effective and active dissemination of Sea Grant information and research. Achieving this goal involves translating and transferring the results of Sea Grant-supported research to individuals, agencies, and user groups in need of information about the coastal marine environment. In addition, the WHOI Sea Grant communications program reaches out to the general public and education sectors in an attempt to answer questions, increase environmental awareness, improve science literacy, and bridge the gap between scientific research (especially marine research) and public knowledge.

For More Information

If you have questions or would like more information about anything you've read in *All About Oceanography*, write or call the following programs:

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